SAHA SAN ANTONIO HOUSING AUTHORITY
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818 S. FLORES ST. SAN ANTONIO, TEXAS 78204 www.saha.org

Procurement Department

REQUEST FOR PROPOSALS

For

Construction Management/Commissioning Agent - EPC II

For
HOUSING AUTHORITY OF THE CITY OF SAN ANTONIO, TEXAS AND AFFILIATED ENTITIES

RFP#: 2006-961-14-5035

Prepared by:

Department of Procurement
of
The San Antonio Housing Authority
818 South Flores Street
San Antonio, Texas 78204

President and CEO …….... David Nisivoccia

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Exhibit E - Insurance Requirements

Section A
Background Information and Evaluation

I. Background Information: The San Antonio Housing Authority d/b/a San Antonio Housing Authority ("SAHA") is a public housing agency created by resolution of the City of San Antonio in 1938 pursuant to the Texas Housing Authorities Law (now Chapter 392 of the Texas Local Government Code) and federal law. SAHA is a unit of government and its functions are essential governmental functions. The property of SAHA is used for essential public and governmental purposes and is exempt from all taxes, including sales tax on all its purchases of supplies and services.

SAHA enters into and executes contracts and other instruments that are necessary and convenient to the exercise of its powers. SAHA maintains contractual arrangements with United States Department of Housing and Urban Development (HUD) to manage and operate its low rent public housing program and administers the Section 8 Housing Assistance Payments Programs. SAHA programs are federally funded along with development and modernization grants and rental income.

Its primary activity is the ownership and management of over 6,300 public housing units. It also administers rental assistance for almost 12,000 privately owned rental units through the Section 8 program. It operates and manages its housing developments to provide decent, safe, sanitary and affordable housing to low income families, the elderly, and the disabled, and implements various programs designed and funded by HUD.

SAHA has created a number of affiliated public facility corporations ("PFCs") pursuant to Chapter 303 of the Texas Local Government Code (the Public Facility Corporation Act). In some instances, these PFCs own projects. In other cases, PFCs or other related entities serve as partners in partnerships that have been awarded low-income housing tax credits. SAHA's affiliated entities own and operate over 3,000 units of affordable housing.

SAHA staff also manages the San Antonio Housing Finance Corporation ("Finance Corporation"), which is primarily a conduit issuer of bonds for developers of affordable housing projects. The Finance Corporation was created pursuant to Chapter 394 of the Texas Local Government Code (the Texas Housing Finance Corporations Act). When used herein, "SAHA" shall include its affiliated entities.

As a part of our social mission and federal mandate, SAHA is committed to providing economic, training and educational opportunities to the low income individuals in the communities we serve. All contractors are required to recruit and hire low income individuals for new positions and provide training & educational opportunities to the greatest extent feasible for these individuals.

SAHA is governed by a Board of Commissioners and managed on a day-to-day basis by its President and CEO. The SAHA Board of Commissioners, upon the advice of the President and

CEO, approves all major policy and contractual decisions. The President and CEO is then charged with implementing these actions.

II. Construction Management/Commissioning Agent - EPC II Opportunity:

The Housing Authority of the City of San Antonio, Texas and its affiliated entities d/b/a San Antonio Housing Authority ("SAHA") hereby invites qualified firms to provide qualified firms to provide the following services:

- Construction administration consistent with the Requirements outlined in Exhibit A – Investment Grade Energy Audit and Exhibit B - Project Specifications and Exhibit C- General Contract Administration and Commissioning Requirements
- A commissioning ("Cx") agent to conduct Cx activities consistent with the Requirements outlined in Exhibit A, Exhibit B and Exhibit C.
- An EPC is a financing tool where energy and water conservation measures ("ECM") are financed and installed through future utility savings generated through reduced utility consumption. Examples of ECMs include lighting retrofits, low flow fixtures, appliances, building envelope improvements, furnaces, water heaters, boilers, central plants, and other energy and water savings improvements. This service shall be provided on an "as needed" basis.

III. Timeline:

DATE ISSUED	June 16, 2020
NON-MANDATORY PRE-SUBMITTAL MEETING	At this time no meeting is required due to the gathering restrictions. All questions will be submitted to point of contact above.
LAST DATE FOR QUESTIONS	June 26, 2020
PROPOSAL DUE DATE	July 2, 2020 at 2:00 P.M. SAHA Procurement Dept. 818 S. Flores, San Antonio, TX 78204
ANTICIPATED APPROVAL BY THE BOARD	August/September 2020

SAHA reserves the right to modify this schedule at their discretion. Notification of changes in connection with this solicitation will be made available to all interested parties via an emailed Addendum.

IV. Objectives:

A. SAHA intends to execute a Contract with the successful offeror(s) who demonstrate they is/are experienced, licensed, and considered the most qualified firm to ensure

that the EPC II meets all HUD EPC Cx requirements which can be found on HUD's website: https://www.huduser.gov/portal/sites/default/files/pdf/EPC.pdf .

B. The Commissioning Agent is responsible for ensuring that the SAHA Phase II EPC meets all HUD EPC Commissioning requirements.

C. Respondents can partner or identify subcontractors/consultants to supplement their team. All, none or other assignments may be developed over the course of the contract period. The SAHA reserves the right to award all, none or specific scopes of work to one or multiple firms included in this Request for Proposals.

V. Requirements:

- The Respondent's project team must include at least (1) licensed professional engineer and at least (1) Certified Commissioning Professional from the Building Commissioning Association, plus five years of demonstrated commissioning experience.

- The energy and water performance EPC specifications are provided in Exhibit A and Exhibit B. Any and all changes conducted by the Cx Agent must ensure all EPC ordered products comply with both Exhibit A and Exhibit B.

- The Contractor must be able to perform services on an as needed basis throughout the term of the Contract dependent upon the Requirements of this RFP.

- Respondent must be a company engaged in the business of providing Commissioning Agent Services and/or Construction Management for a minimum of five years within the last three years. Recent start-up businesses do not meet the requirements of this solicitation. NOTE: A start-up business is defined as a new company that has no previous operational history or expertise in the relevant business and is not affiliated with a company that has that history or expertise. Two companies are affiliated if the companies have a common parent company or if one is the parent or subsidiary of the other

VI. Evaluation:

Each proposal submittal will be evaluated based upon the following information and criteria:

A. **Initial Evaluation-Responsiveness:** Each proposal received will first be evaluated for responsiveness (i.e., meeting the minimum requirements as stated in the RFP).

B. **Evaluation-Responsibility:** SAHA shall select a minimum of a three-person panel, using the criteria established below, to evaluate each of the proposals submitted in response to this RFP to determine the Respondent's level of responsibility. SAHA will consider capabilities or advantages that are clearly described in the proposal that may be confirmed by oral presentations, site visits, demonstrations, and references contacted by SAHA. All proposals would be evaluated as to their overall value to SAHA.

C. **Restrictions:** All persons having familial (including in-laws) and/or employment relationships (past or current) with principals and/or employees of a Respondent will be excluded from participation on SAHA's evaluation panel. Similarly, all persons having ownership interest in and/or contract with a Respondents will be excluded from participation on SAHA's evaluation panel.

D. **Evaluation Criteria:** The evaluation panel will use the following criteria to evaluate each proposal:

5 Excellent
4 Above Average
3 Average
2 Below Average
1 Poor
0 Non Responsive

No.	Point	Weighted Average	CRITERION DESCRIPTION
1	0-5	30%	**Experience:** Depth and breadth of Respondent's experience and qualifications beyond the Minimum Qualifications; Satisfactory record of performance with similar, preferably governmental entities with minimum of 5 years of Cx experience. possesses the necessary experience with HUD, public housing authorities, affordable housing, EPCs, and or self-managed EPCs. Personnel identified as primary staff assigned to the services must have appropriate levels of experience for the services.
2	0-5	25%	**Project Approach and Capability:** Respondent's proposed construction management and commissioning approach for this project demonstrates proven methodology for managing and controlling risks and avoiding schedule slippage. Capacity to execute proposed methodology and satisfactorily duties in a timely and on budget manner. Respondent's financial and staffing capacity supports a project of this size and scope. Current number of active projects which may affect project manpower and schedules.
3	0-5	10%	**Strength of the Section 3 Plan**
4	0-5	10%	**Strength of the S/W/MBE Plan**
5	0-5	25%	**Compensation:** Determination of the lowest overall lump sum cost for all services requested in this RFP.
		100%	**Total Points for Criteria**
		MAX. POINTS	HUD SECTION 3
1		5	**Section 3 Preference: A firm may qualify for Section 3 status for up to an additional 5 points.**
a		5	**Category I: As detailed in Attachment D**
b		4	**Category II: As detailed in Attachment D**
c		3	**Category III: As detailed in Attachment D**
d		2	**Category IV: As detailed in Attachment D**

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E. Competitive Range: Once a competitive range is established from the proposals submitted, SAHA reserves the right to require Respondents within the competitive range to make a presentation to the evaluation committee. Presentations, if requested, shall be a factor in the award recommendation.

VII. Minimum Qualifications: Respondents must meet the following criteria:

A. Type of Organization: Individuals, Firms or joint ventures of firms with a demonstrated record of expertise in one or more of the following:

- Minimum of 5 years' experience in Cx Experience with HUD, public housing authorities, affordable housing, EPCs, and or self-managed EPCs
- Proven record of successful Cx Experience work with residential housing/multi-family projects including expertise in energy/water efficiency retrofitting for similar housing organizations.
- Minimum of 5 or more successful Cx services provided to other entities in the past 5 years.
- The respondent's project team must include at least (1) licensed professional engineer and at least (1) Certified Commissioning Professional from the Building Commissioning Association, plus five years of demonstrated commissioning experience.

End Section A

Section B
Instructions to Respondents

I. **Point of Contact**: The point of contact for purposes of obtaining the Request for Proposal and to submit responses is:

POINT OF CONTACT	Lucio Tovar, Contract Specialist San Antonio Housing Authority 818 S. Flores San Antonio, TX 78204 Phone: (210) 477-6703 E-mail: lucio_tovar@saha.org

The Request for Proposals can be obtained by calling 210-477-6059 or online at

www.saha.org

https://ha.internationaleprocurement.com/

http://www.publicpurchase.com/gems/saha,tx/buyer/public/home

All Addenda will be posted on SAHA's website www.saha.org, https://ha.internationaleprocurement.com/ and www.publicpurchase.com. Any changes that are issued before the proposal submission deadline shall be binding upon all prospective Respondents.

Respondents shall address all communication and correspondences pertaining to this RFP process to only the Contact person identified above. Respondents must not inquire or communicate with any other SAHA staff member or official (including members of the Board of Commissioners) pertaining to this RFP. Failure to comply with this requirement is cause for a proposal to be disqualified. During the RFP solicitation process, SAHA will not conduct any ex parte conversations which may give one prospective Contractor an advantage over other prospective Respondents.

II. Prohibitions: Contact with members of the SAHA Board of Commissioners, or SAHA officers and employees other than the contact person listed herein**,** by any prospective Contractor, after publication of the RFP and prior to the execution of a contract with the successful Contractor(s) could result in disqualification of your proposal. In fairness to all prospective Contractor(s) during the RFP process, if SAHA meets in person with anyone representing a potential provider of these services to discuss this RFP other than at the pre-submittal meeting, an addendum will be issued to address all questions so as to insure no Contractor has a competitive advantage over another. This does not exclude meetings required to conduct business not related to the RFP, or possible personal presentations after written qualifications have been received and evaluated.

III. Non-Mandatory Pre-Proposal Conference: Due to the current restrictions on meetings a pre-submittal conference will not be held.

IV. SAHA'S Reservation of Rights:

SAHA reserves the right, without liability, to:

- reject any or all proposals, to waive any informality in the RFP process, or to terminate the RFP process at any time, if deemed by SAHA to be in its best interests.
- award a contract pursuant to this RFP
- terminate a contract awarded pursuant to this RFP, at any time for its convenience upon 30 days written notice to the successful Respondent.
- determine the days, hours and locations in which the services are performed in this RFP.
- retain all proposals submitted and not permit withdrawal for a period of 90 days subsequent to the deadline for receiving proposals without the written consent from SAHA.
- negotiate the fees proposed by all Respondents. If such negotiations are not, in the opinion of SAHA successfully concluded within a reasonable timeframe as determined by SAHA, SAHA shall retain the right to end such negotiations.
- reject and not consider any proposal that does not meet the requirements of this RFP, including but not necessarily limited to rejection of incomplete proposals and/or proposals offering alternate or non-requested services and from Respondents deemed non- responsive and non-responsible.
- prohibit any further participation by a Respondent or reject any proposal submitted that does not conform to any of the requirements detailed herein. Each prospective Respondent further agrees that he/she will inform SAHA in writing within five (5) days of the discovery of any item that is issued thereafter by SAHA that he/she feels needs to be addressed. Failure to abide by this timeframe shall relieve SAHA, but not the prospective Respondents, of any responsibility pertaining to such an issue.
- award, to revise, change, alter or amend any of the instructions, terms, conditions, and/or specifications identified within the RFP documents issued, within any attachment or drawing, or within any addenda issued.
- to advertise for new proposals or to proceed to do the work otherwise if proposals are rejected.
- cancel the award of any proposal(s) at any time before the execution of the contract documents by all parties.
- reduce or increase estimated or actual quantities in whatever amount necessary if funding is not available, legal restrictions are placed upon the expenditure of monies for this category of service or supplies, or SAHA's requirements in good faith change after award of the contract.
- make an award to more than one Respondents based on ratings or to make an award with or without negotiations or Best and Final Offers (BAFO).

- establish a competitive range for responses based on the initial scores and to require presentations by the Respondents within the competitive range.
- require additional information from all Respondents to determine level of responsibility. Such information shall be submitted in the form and time frame required by SAHA.
- amend the terms of the contract any time prior to contract execution.
- contact any individuals, entities, or organizations that have had a business relationship with the Respondents regardless of their inclusion in the reference section of the proposal submittal.

V. Timely Submissions: Late submissions will not be accepted. Proposals received prior to the submittal deadline shall be securely kept, unopened, by SAHA. No proposal received after the designated deadline shall be considered. Respondents are cautioned that any proposal submittal that is time-stamped as being received by SAHA after the exact time set as the deadline for the receiving of proposals shall not be considered. Any such proposal inadvertently opened shall be ruled to be invalid. No responsibility will attach to SAHA or any official or employee thereof, for the pre-opening of, or the failure to open a proposal not properly addressed and identified.

VI. Pre-Qualification: Respondents will not be required to pre-qualify to submit a proposal. However, all Respondents will be required to submit adequate information showing that the Respondents is qualified to perform the required work

VII. Review of RFP Forms, Documents, Specifications and Drawings: It shall be each Respondent's responsibility to examine carefully and, as may be required, properly complete all documents issued pursuant to this RFP. Unless otherwise instructed, specifications and drawings (if provided) do not purport to show all of the exact details of the work. They are intended to illustrate the character and extent of the performance desired under the proposed contract and may be supplemented or revised from time to time.

VIII. Responses: A total of one (1) original signed copy (marked "ORIGINAL") using the Proposal Form attached as Attachment E, one copy of the original on a USB drive or CD, and three (3) exact copies less cost, (marked copy) shall be placed unfolded in a sealed package with the Respondent's name and return address and addressed as follows:

{RFP # {Insert Number}
{Insert Exact Title of RFP}
{Insert Month, day, year, Time of Bid Opening}
The San Antonio Housing Authority
Procurement Department
818 S. Flores
San Antonio, Texas 78204

The Respondents shall bind the proposal such that SAHA can, if needed, remove the binding (i.e. “comb-type, etc.) or remove the pages from the cover (i.e. 3-ring binder, etc.) to make copies then return the proposal submittal to its original condition.

IX. Withdrawal of Proposals: A request for withdrawal of a proposal due to a purported error must be filed in writing by the Respondents within 48 hours after the proposal deadline. The request shall contain a full explanation of the purported error. The foregoing shall not be construed to violate the common law right of withdrawal for material error as defined in State statute. SAHA retains the right to accept or reject any and all bids to the extent permitted by law. Negligence on the part of the Respondents in preparing his/her proposal confers no right of withdrawal or modification of the proposal after such proposal has been received and opened.

X. Mistake in Proposal Submitted: After a proposal has been opened it may not be changed for the purpose of correcting an error in the pricing. This does not affect the common law right of the Respondent to withdraw a bid due to a material mistake in the bid.

A. Irregular Proposal Submittal: A proposal shall be considered irregular for any one of the following reasons, any one or more of which may, at SAHA's discretion, be reason for rejection:

- If the forms furnished by SAHA are not used or are altered or if the proposed costs are not submitted as required and where provided.
- If all requested completed attachments do not accompany the proposal submittal.
- If there are unauthorized additions, conditional or alternate proposals, or irregularities of any kind which may tend to make the proposal incomplete, indefinite or ambiguous as to its meaning or give the Respondents submitting the same a competitive advantage over other Respondents.
- If the Respondent adds any provisions reserving the right to accept or reject any award or to enter into a contract pursuant to an award.

XI. Disqualification of Respondents: Any one or more of the following shall be considered as sufficient for the disqualification of a prospective Respondents and the rejection of his/her proposal:

- Evidence of collusion among prospective Respondents. Participants in such collusion will receive no recognition as Respondents or Respondents for any future work with SAHA until such participant shall have been reinstated as a qualified bidder or Respondent. The names of all participants in such collusion shall be reported to HUD and any other inquiring governmental agency.
- More than one proposal for the same work from an individual, firm, or corporation under the same or different name(s).

- Lack of competency, lack of experience and/or lack of adequate resources.
- Unsatisfactory performance record as shown by past work for SAHA or with any other local, state or federal agency, judged from the standpoint of workmanship and progress.
- Incomplete work, which in the judgment of SAHA, might hinder or prevent prompt completion of additional work, if awarded.
- Failure to pay or satisfactorily settle all bills due on former contracts still outstanding at the time of award.
- Failure to demonstrate minimum qualification requirements of SAHA.
- Failure to list, if required, all team members, subcontractors (if subcontractors are allowed by SAHA) who will be engaged by the successful Respondent(s) to participate in the Project.
- Failure of the successful Respondents to be properly licensed by the City, County and/or the State of Texas and/or to be insured by a commercial general liability policy and/or worker's compensation policy and/or business automobile liability policy, if applicable.
- Any reason to be determined in good faith, to be in the best interests of SAHA.

XII. Questions/Inquiries: A Respondent may inquire or question any of the proposal documents or any part of the information contained therein, by submitting, in writing to the contact person listed herein, at least eight (8) days prior to the proposal submission deadline, a complete and specific explanation as to what he/she is requiring clarification. SAHA reserves the right to issue a revision to the applicable RFP requirements in the form of an Addendum or may reject the Respondent's request.

XIII. Substitutions: Respondents must propose a Project that meets the requirements of the RFP documents. All verbal communications or instructions provided by any SAHA personnel shall only become official and binding when issued as an addendum by the SAHA Procurement Department.

XIV. No Liability for Costs: SAHA assumes no liability or responsibility for the costs incurred by the Respondents for any materials, efforts or expenses required in the preparation of proposals or in connection with presentations or demonstrations prior to the issuance of a Contract.

XV. Proposal Opening Results: Proposals are publicly opened and the results are generally a matter of public record. When SAHA has concluded all evaluations, has chosen a final top-rated Respondent, has completed the award and is ready to issue such results, SAHA shall notify the successful Respondents. All proposal documents submitted by the Respondents are generally a matter of public record unless such information is deemed to be proprietary.

XVI. Award: Submissions will be evaluated on the criteria stated in Section A of this RFP. After evaluation of the responses, the Contract will be awarded to the Respondents representing the "Best Value" to SAHA after preferences for Section 3 business concerns are considered. The Selected Contractor will then enter into a development agreement with SAHA. SAHA reserves the right to issue a separate RFP for property management services.

A. Term and Type of Contract Award: Firm fixed contract with the option to extend for up to four additional one (1) year periods at the sole discretion of SAHA.

XVII. Taxes. SAHA, as a governmental entity, is exempt from Texas State Sales and Use Taxes and Federal Excise Taxes. A letter of Tax Exemption will be provided upon request.

XVIII. Insurance: If a Respondent receives an award and unless otherwise waived in the Contract, the Selected Contractor will be required to provide an original Certificate of Insurance confirming the minimum requirements found within Exhibit 2 to SAHA within 10 days of contract signature.

XIX. Exceptions. SAHA will consider any exception to the RFP that the Respondent wishes to include but the failure of SAHA to include such exceptions does not give the successful Respondent the right to refuse to execute SAHA's contract form. It is the responsibility of each prospective Respondent to notify SAHA, in writing, in its Proposal of any exceptions to the RFP terms. SAHA will consider such clauses and determine whether or not to include in the Contract.

XX. <u>RIGHT TO PROTEST:</u>

A. Rights: Any prospective or actual Respondents or contractor, who is allegedly aggrieved in connection with the solicitation of a proposal or award of a contract, shall have the right to protest. Such right only applies to deviations from laws, rules, regulations, or procedures. Disagreements with the evaluators' judgments as to the number of points scored are not reasons for an appeal. An alleged aggrieved protestant claiming this right is hereby informed that these regulations do not provide for administrative appeal as a matter of right for that alleged aggrieved protestant.

A.1 Definition: An alleged aggrieved "protestant" is a prospective Respondents or Respondents who feels that he/she has been treated inequitably by SAHA and wishes SAHA to correct the alleged inequitable condition or situation.

A.2 Eligibility: To be eligible to file a protest with SAHA pertaining to an RFP or contract, the alleged aggrieved protestant must have been involved in the RFP process in some manner as a prospective Respondents (i.e. recipient of the RFP documents) when the alleged

situation occurred. SAHA has no obligation to consider a protest filed by any party that does not meet these criteria.

A.3 **Procedure:** Any actual or prospective contractor may protest the solicitation or award of a contract for material violation of SAHA's procurement policy. Any protest against a SAHA solicitation must be received before the due date for receipt of Proposals or proposals and any protest against the award of a contract must be received within ten calendar days after the contract award or the protest will not be considered.

All protests must be in writing and submitted to the Director of Procurement for a written decision. The Director of Procurement shall make a recommendation to the Contracting Officer who shall issue a written decision and findings to the Contractor within 30 days from receipt of the written protest. This decision is then appealable to the Board of Commissioners within 30 days of receipt of the written decision. Appeals which are not timely filed will not be considered and the decision becomes final. All appeals shall be marked and sent to the address as listed in the following example:

APPEAL OF RFP NO. (insert exact number of RFP here)
San Antonio Housing Authority
Attn: Procurement Department
818 South Flores Street
San Antonio, TX 78204

End Section B

Section C
Information To Be Submitted

The response to this RFP shall be submitted in the manner described in this Section. Each category must be separated by index dividers and the index divider must extend so that each tab can be located without opening the proposal and labeled with the corresponding tab reference noted below. Failure to submit the proposal in the manner specified may result in a premature opening of, post-opening of, or failure to open and consider that proposal and may be cause for elimination of that Respondent from consideration for award.

C.1 Tab 1, Profile of Firm and Company Biography:
Respondents will be required to complete and return these forms as indicated and place them under this tab.

This information shall be submitted under the Tab 1 of Section C.

C.2 Tab 2, Project Approach and Capability
The Respondent shall provide its methodology and approach for providing the Construction Management and Commissioning services requested by this RFP including a detailed description of methodology and efforts to be employed by Respondent to meet the Requirements found in Exhibit A, B and C. This narrative should include a description of all relevant aspects of the Project approach including:

a. Summary of Firm's approach for assignment of individuals and scope of professional services to meet the Requirements The narrative should include staffing assignments, organizational structure, logistical issues, and other issues.
b. Projected timeline, key critical path items and any other other competing projects that show that the Respondent has the capacity to work on a project of this magnitude;
c. Organization chart and identification of all staff that will be assigned to this scope of work to include a brief resume, job description and title of the person or persons, **Resumes are not considered in the 20 page limit and should be listed as an attachment or exhibit)**
d. Resumes for the primary Professional Engineer on the project and the Certified Commissioning Professional that will be performing the work;
e. A description of the duties and responsibilities of each personnel working title and that could include: project managers, maintenance staff, financial consultants, accountants, architects & engineers, etc.;
f. If applicable, an explanation of the structure of any joint venture or partnership and how responsibilities will be divided. Provide names and contact information for any additional Respondents involved with the project.
g. Description and examples of documents/reports and/or information that will be provided;
h. Summary of resources required from SAHA Staff;

i. Respondent shall provide current financials or copies of the interim financial statement/s showing income, expenses reserves, and cash flow which can substantiate the Respondent's ability to perform without pre-payments from SAHA. In addition, any details which describe the financial strength of the Respondent may be provided including but not limited to: details of any material events that may affect the entity's financial standing such as; details of any credit rating; details of any bankruptcy, insolvency, company creditor arrangement or other insolvency litigation in the last three fiscal years.

This information shall be submitted in the form of Tab 2 to Section C.

C.3 Tab 3, Experience

a. Respondent's Proposal shall contain a description of the Respondent's firm/team, history including the resumes of the individual(s)/team that will be assigned to conduct the services for SAHA. Respondents should include resumes of key staff.
b. Respondent shall provide a narrative detailing a minimum of 5 years CX and Construction management experience. Specifically note any experience with HUD, public housing authorities, affordable housing, EPCs, and or self-managed EPCs.
c. Respondent shall provide examples of such work with residential housing/multi-family projects and include any expertise in energy/water efficiency retrofitting.
d. Respondent shall provide a list of clients of comparable size and type of work the Respondent has delivered in the last five years and three reference letters or 3 three letters of recommendation of related projects completed within the past 5 years.
e. Respondent shall provide documentation addressing whether the Respondent, or any participating member of the team, has been involved in any litigation or legal dispute against the State of Texas or any agency, department, authority or subdivision of the State or any litigation or legal dispute regarding construction management and/or commissioning agent services during the past five years.
f. Respondent shall identify three former or current clients, preferably other than SAHA, for whom the Respondent has performed similar or like services to those being proposed herein. The list shall, at a minimum, include for each reference the client's name, telephone number and address, description of services provided to the client, and date of services.

C.4 Tab 4, Compensation

A. Respondent shall provide a lump sum fee for all services requested in this RFP. SAHA will not pay any additional costs above of the lump sum fee such as but not limited to reimbursables, travel, additional trips, mileage, copies, and any unanticipated additional time spent on the project contained in this RFP.

This information shall be included as Tab 4 of Section C.

C.5 Tab 5, HUD Forms, Conflict of Interest Questionnaire and Form 1295:
These Forms are attached hereto as Attachment D to this RFP document must be fully completed, except as noted, executed where provided thereon, and submitted under this tab as a part of the proposal submittal. The successful Respondent shall be required to submit a Form 1295 to the Texas Ethics Commission in compliance with Government Code 2252.908 and a copy of the submission along with the Certification prior to execution of the contract with SAHA.

This information shall be included as Tab 5 of Section C.

C.6 Tab 6, Section 3 Business Preference: Any Respondent claiming a Section 3 Business Preference, shall under this tab include the fully completed and executed Section 3 applicant certification form for low-income employees for whom Respondent is seeking the preference, verification of total number of full-time employees, names and addresses of low-income residents who are Respondents employees. **Note: If you qualify as a Section 3 Business Concern, your Qualifications will receive a preference over other respondents as specified in Attachment C.**

This information shall be included as Tab 6of Section C.

C.7 Tab 7, Small/Minority/Disadvantaged/Veteran Business Enterprise Utilization Plan: The Respondents shall submit a plan that details how the Contractor will make a good faith effort to subcontract with S/W/MBE companies. Opportunities to subcontract with S/W/MBE may include:

- Delivery and Runner Services
- Office Supplies
- Temporary Personnel
- Other Legal or Professional firms
- Printing & binding

FAILURE TO PROVIDE THE S/W/MBE PLAN MAY CAUSE THE RESPONSE TO BE DISQUALIFIED AS NON-RESPONSIVE.

This information shall be included as Tab 7 of Section C.

C.8 Tab 8, Section 3 Good Faith Effort Compliance Plan:
Respondents are required to complete and submit the SECTION 3 PROGRAM GOOD FAITH EFFORT COMPLIANCE PLAN outlining their efforts to employ qualified Section 3 businesses or persons. The goal as stated in the Good Faith Effort Compliance Plan is thirty percent (30%) of new hires for Section 3 persons per contract. The subcontracting goal is ten percent (10%) for Section 3 Businesses for construction contracts and three percent (3%) for Section 3 Businesses for non-construction contracts. SAHA will provide a listing of qualified Section 3 Businesses upon request. See C6 above for potential areas to subcontract.
FAILURE TO PROVIDE THE SECTION 3 PROGRAM GOOD FAITH EFFORT COMPLIANCE PLAN MAY CAUSE THE RESPONSE TO BE DISQUALIFIED AS NONRESPONSIVE.

This information shall be included as Tab 8 of Section C.

C.9 Tab 9, Proposal Checklist and Certification:
Respondent shall certify that the Proposal documents are complete and included in the response and to the Certification contained in Attachment E.

This information shall be included as Tab 9 of Section C.

End Section C

Section D
Terms and Conditions

These Terms and Conditions shall be considered required terms of any Contract between the Successful Respondent and SAHA. The Contractor must also be familiar with federal guidelines issued by HUD known as the "General Conditions for Non-Construction Contracts" (see form HUD 5370 C1). These guidelines, together with any supplemental general conditions issued by HUD, outline requirements for the conduct of work and administrative requirements.

I. GENERAL RESPONSIBILITIES:

A. Specifications. The Contractor shall provide the Project in accordance with the Specifications which are stated in Section A. IV above.

B. Regulatory/Licensing. Contractor shall comply with all applicable federal, state and local laws, rules, regulations, ordinances and codes and obtain any licenses or permits required to provide the services. Obtaining licenses and permits shall be the sole responsibility of the Contractor.

C. Timesheets. Contractor shall keep accurate timesheets for all employees assigned to perform any project, task, or assignment in the Project.

D. Unacceptable Employees: If any employee of the Contractor is deemed unacceptable by SAHA, Contractor shall immediately replace such personnel with a substitute acceptable to SAHA.

E. Uniforms/Badges: Contractor shall provide uniforms and/or ID badges for all employees working on SAHA's properties. No employee will be allowed on SAHA's properties out of uniform and/or without an ID badge.

F. Criminal History: Contractor shall perform criminal history checks on all employees performing work on SAHA property and if requested provide summaries of the results to SAHA. Prospective employees whose criminal history checks discloses a misdemeanor or felony conviction involving crimes of moral turpitude or harm to persons or property shall not be used to perform work under this RFP or any resulting contract. Criminal history and drug screening checks will be completed at the sole expense of the Contractor.

G. Drug Screening: Respondent by submitting a response to this solicitation certifies that it is in compliance with the "Drug Free Workplace Act". Respondent agrees that if awarded a contract and upon a reasonable request by SAHA respondent will have tested immediately any employee suspected of being under the influence of drugs or alcohol and if positive remove them permanently from assignments on SAHA owned properties.

H. Work on SAHA Property: The Contractor shall take all necessary precautions to prevent the occurrence of any injury to persons or property during the progress of such work and shall immediately return said property to a condition equal to or better than the existing condition prior to the commencement of work at the site at no cost to SAHA.

I. Wages. Contractor shall pay all salaries and expenses of, and all Federal, Social Security taxes, Federal and State Unemployment taxes, and any similar taxes relating to its employees used in the performance of the contract. The Contractor further agrees to comply with all Federal, State and local wage and hour laws and all licensing laws applicable to its employees or other personnel furnished under the agreement.

J. Independent Contractor: The Contractor shall be considered an independent contractor. Nothing herein shall create any association, agency, partnership or joint venture between the parties hereto and neither shall have any authority to bind the other in any way.

II. **SECTION 3 REQUIREMENTS. Contractor is required to prepare and submit monthly reports on Section 3.** Contractor shall utilize Section 3 residents and businesses as defined in Attachment D to perform the requirements under the Project to the greatest extent feasible and shall document such efforts monthly. Contractors will be evaluated on their performance at achieving this goal and such evaluation shall be a factor in future awards.

III. **SUBCONTRACTORS**. Contractor may not use any subcontractors to accomplish any portion of the services described within the RFP documents or the contract without the prior written permission of the SAHA. Also, any substitution of subcontractors must be approved in writing by SAHA prior to their engagement. All requirements for the "Prime" Contractor shall also apply to any and all subcontractors. It is the Contractors' responsibility to insure the compliance by the subcontractors. Regardless of subcontracting, the Contractor remains liable to SAHA for the performance under the contract. The Contractor shall assure that its subcontractors comply with all applicable HUD regulations and SAHA requirements including but not limited to Section 3 requirements, insurance, Davis Bacon wage requirements and reporting, permitting, code compliance, and licensure.

IV. LIMITATION/INDEMNIFICATION/INSURANCE

A. Limitation of Liability: In no event shall SAHA be liable to the successful Respondents for any indirect, incidental, consequential or exemplary damages.

B. Indemnification. The Contractor shall indemnify and hold harmless SAHA and its officers, agents, representatives, and employees from and against all claims, losses, damages, actions, causes of action and/or expenses resulting from, brought for, or on account of any bodily injury or death of an employee of the Contractor, its agent,

or its subcontractor of any tier received or sustained by any persons or property growing out of, occurring, or attributable to any work performed under or related to this Agreement, to the extent resulting in whole or in part from the negligent acts or omissions of the Contractor, any subcontractor, or any employee, agent or representative of the Contractor or any subcontractor. **Contractor ACKNOWLEDGES AND AGREES THAT THIS INDEMNITY CONTROLS OVER ALL OTHER PROVISIONS IN THE AGREEMENT, SURVIVES TERMINATION OF THIS AGREEMENT.**

For clarification purposes**,** Contractor shall indemnify and hold harmless SAHA, their agents, consultants and employees from and against any and all property damage claims, losses, damages, costs and expenses relating to the performance of this Agreement, including any resulting loss of use, *but only to the extent caused by the negligent acts or omissions of Contractor*, its employees, sub-subcontractors, suppliers, manufacturers, or other persons or entities for whose acts Contractor may be liable.

V. SAHA Actions. It is agreed by and between the parties hereto that in no event shall any official, officer, employee, or agent of SAHA in any way be personally liable or responsible for any covenant or agreement herein contained whether expressed or implied, nor for any statement, representation or warranty made herein or in any connection with this agreement.The Contractor agrees to execute the contract, and shall make no claim against SAHA because of estimates or statements made by any officer or agent of SAHA that may prove to be in any respect erroneous.

VI. Insurance: The Contractor shall maintain in full force and effect during the entire contract term insurance in the form and in amounts found in Exhibit 2.

VII. LIQUIDATED DAMAGES: For each day that performance under the contract is delayed beyond the time specified for completion, the successful Respondents shall be liable for liquidated damages in the amount reflected in the contract. However, the timeframe for performance may be adjusted at SAHA's discretion in writing prior to default under the contract.

VIII. WARRANTY.

A. General Warranty. The Respondent represents and warrants to the Customer that the Respondent will perform the Services with reasonable care and skill and in accordance with best commercial practices and standards in the industry for similar services.

IX. INVOICING:

A. Invoices. Invoices must contain a complete description of the work or service that was performed, the contract price for each service, the purchase order number, contract number (if applicable), date of service, and address of service location or delivery address. Contractor(s) must submit a separate invoice for each purchase

order issued by SAHA unless prior approval is obtained from SAHA. To insure prompt and timely payment of invoices, and unless utilizing a progress payment schedule, invoices shall be sent electronically to the following address:

Accounts_Payable@saha.org

If the Contractor does not have the capability to send invoices electronically they may be mailed to:

San Antonio Housing Authority
Finance and Accounting
P.O. Box 830428
San Antonio, TX 78283-0428

B. Progress Payments. If applicable, SAHA may make progress payments approximately every 30 days as the work proceeds if work meets owner's standards, as approved by the Contracting Officer. SAHA may, subject to written determination and approval of the Contracting Officer, make more frequent payments to contractors which are qualified small businesses in accordance with HUD documents.

C. Direct Deposit. Upon the Award of Contract, Contractor shall complete a form for direct deposit to process all payments electronically to insure prompt and efficient payment of all invoices.

D. Contractor shall invoice SAHA within 60 days after the delivery of the goods or service. If contractor fails to invoice within 60 days SAHA reserves the right to not pay the invoice.

X. Laws and Regulations

A. General. SAHA is a governmental entity as that term is defined in the procurement statutes. SAHA and this RFP and all resulting contracts are subject to federal, state and local laws, rules, regulations and policies relating to procurement as applicable. Contractor shall comply with all local, state and federal laws concerning safety (OSHA) and environmental control (EPA and Bexar County Pollution Regulations) and any other enacted ordinance, code, law or regulation. Contractor shall be responsible for all costs incurred for compliance with any such possible ordinance, code, law or regulation. No time extensions shall be granted or financial consideration given to the Contractor for time or monies lost due to violations of any such ordinance, code, law or regulations that may occur.

B. Specific. Contractors shall comply with all statutes, rules, regulations, executive orders affecting procurements by Housing Authorities including but not limited to:

- Executive Order 11246
- Executive Order 11063
- Copeland "Anti-Kickback" Act (18 USC 874)
- Davis Bacon and Related Acts (40 USC 276a-276a-7)

- Clean Air & Water Acts (42 USC 1857(h); 33 USC 1368)
- Contract Work Hours & Safety Standards Act (40 USC 327-330)
- Energy Policy & Conservation Act (PL 94-163, 89 STAT 871)
- Civil Rights Act of 1964, Title VI (PL 88-352)
- Civil Rights Act of 1968, Title VIII (PL 90-284 Fair Housing Act)
- Age Discrimination Act of 1975
- Anti-Drug Abuse Act of 1988 (42 USC 11901 et. Seq.)
- HUD Information Bulletin 909-
- Immigration Reform & Control Act of 1986
- Fair Labor Standards Act (29 USC 201, et. Seq.

C. Incorporation. Each provision of law and each clause, which is required by law to be inserted in this RFP or any contract, shall be deemed to have been inserted herein, and this RFP and any resulting contract shall be read and enforced as though such provision or clause had been physically inserted herein. If, through mistake or otherwise, any such provision is not inserted or is inserted incorrectly, this agreement shall forthwith be physically amended to make such insertion or correction upon the application of either party. The fore-mentioned statutes, regulations and executive orders are not intended as an indication that such statute, regulation or executive order is necessary applicable nor is an omission of such statute, regulation or executive order intended to indicate that it is not applicable.

XI. Termination.

A. Early Termination. In the event any resulting contract is prematurely terminated due to non-performance and/or withdrawal by the Contractor, SAHA reserves the right to seek monetary restitution (to include but not limited to withholding of monies owed) from the Contractor to cover costs for interim services and/or cover the difference of a higher cost (difference between terminated Contractor's rate and new company's rate) beginning the date of Contractor's termination through the contract expiration date. The contract may be terminated under the following conditions:

a. Consent: By mutual consent of both parties, and

b. Termination For Cause: As detailed within the attached HUD Forms. SAHA may terminate any and all contracts for default at any time in whole or in part, if the Contractor fails to perform any of the provisions of any contract, so fails to pursue the work as to endanger performance in accordance with the terms of the RFP or any resulting contracts, and after receipt of written notice from SAHA, fails to correct such failures within seven (7) days or such other period as SAHA may authorize or require.

c. Failure to Fund. SAHA may terminate any contract resulting from this RFP in whole or in part, if funding is reduced, or is not obtained and continued at levels sufficient to allow for the expenditure.

d. Termination for Convenience: In the sole discretion of the Contracting Officer, SAHA may terminate any and all contracts resulting from this RFP in whole or part upon thirty days prior notice to the Contractor when it is determined to be in the best interest of SAHA**.**

B. Action Upon Termination. Upon receipt of a notice of termination issued from SAHA, the Contractor shall immediately cease all activities under any contract resulting from this RFP, unless expressly directed otherwise by SAHA in the notice of termination.

C. Remedies Cumulative. The rights and remedies of SAHA provided under this section are not exclusive and are in addition to any other rights and remedies provided by law or under any contract.

D. Rights Upon Termination. In the event the contract is terminated for any reason, or upon its expiration, SAHA shall retain ownership of all work products including deliverables, source and object code, microcode, software licenses, and documentation in whatever form that may exist. In addition to any other provision, the Contractor shall transfer title and deliver to SAHA any partially completed work products, deliverables, source and object code, or documentation that the Contractor has produced or acquired in the performance of the contract.

XII. General Conditions

A. Severability: If any provision of this agreement or any portion or provision hereof applicable to any particular situation or circumstance is held invalid, the remainder of this agreement or the remainder of such provision (as the case may be), and the application thereof to other situations or circumstances shall not be affected thereby.

B. Waiver of Breach: A waiver of either party of any terms or conditions of this agreement in any instance shall not be deemed or construed as a waiver of such term or condition for the future, or of any subsequent breach thereof. All remedies, rights, undertakings, obligations, and agreements contained in this agreement shall be cumulative and none of them shall be in limitation of any other remedy, right, obligation or agreement of either party.

C. Time of the Essence: Time is of the essence as to each provision in which a timeframe for performance is provided in this RFP. Failure to meet these timeframes may be considered a material breach, and SAHA may pursue compensatory and/or liquidated damages under the contract.

D. Examination and Retention of Contractor's Records: SAHA, HUD, or Comptroller General of the United States, or any of their duly authorized representatives shall, until three years after final payment under all contracts executed as a result of this RFP, have access to and the right to examine any of the Contractor's directly pertinent books, documents, papers, or other records involving

transactions related to this contract for the purpose of making audits, examinations, excerpts and transcriptions.

E. Right to data and Patent Rights: In addition to other ownership & use rights SAHA shall have exclusive ownership of all, proprietary interest in, and the right to full and exclusive possession of all information, materials, documents, software, and all electronic data discovered or produced by Contractor and/or subcontractors pursuant to the terms of the contract, including but not limited to, reports, memoranda or letters concerning the research and reporting tasks of the contract. Both parties agree to comply with HUD Bulletin 909-23, which is the Notice of Assistance Regarding Patent and Copyright Infringement.

F. Force Majeure: Neither SAHA nor Contractor shall be held responsible for delays or default caused by fire, flood, riot, acts of God or war where such cause was beyond, respectively, SAHA or Contractor's reasonable control. Contractor shall make all reasonable efforts to remove or eliminate such a cause of delay or default and shall, upon the cessation of the cause, diligently pursue performance of its obligations under this Agreement.

G. Tx. Gov. Code 2252.152: Prohibits a government entity from awarding a contract to a company identified as Iran, Sudan, or a Foreign Terrorist Organization as identified on the lists maintained by the Texas Comptroller of Public Accounts.

H. Boycott of Israel: Effective 9-1-17: Texas Government Code chapter 2270 prohibits a governmental entity from doing business with any vendor for goods or services unless that vendor verifies in the contract that "they i) do not boycott Israel and ii) will not boycott Israel during the term of the contract".

End Section D

Exhibit A

Investment Grade Energy Audit

PHASE II EPC INVESTMENT GRADE AUDIT

SAN ANTONIO HOUSING AUTHORITY

February 26, 2020

This document is an investment grade energy audit of the resource efficiency opportunities at Blanco, Cheryl West, Christ the King, Col. Cisneros, Cross Creek, Escondida, Frank Hornsby, HB Gonzalez, Highview, Jewett Circle, LC Rutledge, Lewis Chatham, Lila Cockrell, Linda Lou, Madonna, Matt Garcia, Midway, Mirasol, Mission Park, MC Beldon, Pin Oak I, Pin Oak II, Raymundo Rangel, Riverside, Sahara Ramsey, South San, Spring View, Sun Park Lane, TL Shaley, Tarry Towne, Villa Veramendi, Westway, William Sinkin, and Williamsburg.

Table of Contents

1 Executive Summary

Group14 Engineering has conducted an investment grade energy audit of the San Antonio Housing Authority (SAHA) public housing portfolio. This document is the audit project narrative, which identifies energy and water conservation measures (ECMs) for possible inclusion in Phase II of an Energy Performance Contract (EPC).

After review and feedback by SAHA, a bundle of efficiency measures have been selected based on the portfolio's capital needs and the economic requirements of the EPC cash flow pro-forma.

The audit scope included 2,324 public housing units managed by the San Antonio Housing Authority (SAHA). Building types include mid-rises, walk-up apartment buildings, row home sites, and an assortment of detached and semi-detached housing sites. Opportunities for improved energy and water efficiency performance were found in all facilities, ECMs include:

- Replacing inefficient lighting with LED lighting technology
- Replacing standard heat lamps with high efficiency heat lamps
- Replace standard flow water fixtures with low flow aerators, showerheads, and toilets
- Single Pane Window upgrades
- Electric furnace to air source heat pump replacements
- Central boiler plant upgrades
- Installation of new roofs with Solar PV

Group14 recommends that all lights and water fixture measures be implemented to improve EPC financial performance. Longer payback items should be ranked based upon SAHA's capital needs. High priority items will be included in the EPC as allowed by project financials.

The report is organized by ECM category: Water, Lighting, Envelope, and Mechanical system upgrades. Savings are reported by HUD Project Number. This narrative documents existing conditions, performance requirements for the proposed ECMs, and equipment counts. In the investment grade audit to follow this effort, savings calculations, cost estimates, and bid specifications will be provided for each measure.

It should be noted that all existing condition descriptions are provided for audit purposes only. Contractors are required to verify all on-site conditions on which their bids are based.

Group14 would like to thank San Antonio Housing Authority staff and residents for sharing their time and deep knowledge of the housing portfolio.

1.1 ECM Items Key

Tag Name	Description
B1	Install New Modular Power Draft Space Heating Boiler Plant with Setpoint Enable and OA Reset Controls
EF1	Energy Star exhaust fan + 125W heat lamp
FL1	21W LED flood light with motion sensing control
FL2	31W Dual-head LED flood light with motion sensing control
FL3	24W Dual-head LED flood light
FL4	62W LED flood light
HL1	Low wattage heat lamps (125W)
HP	9.5 HSPF heat pumps
HW	Install New Condensing Domestic Hot Water Plant
L1	9.5W LED Bulb
L10a	24W Screw-in LED bulb
L10b	36W Screw-in LED bulb
L10c	54W Screw-in LED bulb
L10d	150W Screw-in LED bulb
L1d	9W GU24 base LEDs
L2	16.5W LED Bulb
L5a	8.5W LED 2 pin bulb
L5b	8.5W LED 4 pin bulb
L5c	12W LED 4 pin bulb
L5d	12W LED 2 pin bulb
L6	7W LED candelabra bulb
L7	10.2W LED Bulb
LC1	36W LED canopy fixture
LC2	17W LED ceiling fixture
LC3	11W LED ceiling fixture
LC4	9W LED decorative ceiling fixture
P1a	52W LED walkway pole light head
P1b	96W LED parking lot pole light head(s)
P1c	166W LED parking lot pole light head(s)
P2b	2x 96W LED parking lot pole light heads
P2c	2x 166W LED parking lot pole light heads

PV1	Install a roof mounted photovoltaic system
RL4 (2')	2' Type C LED Tube with Remote Driver
RL5 (3')	3' Type C LED Tubes with Remote Driver
RL6 (4')	4' Type C LED Tube with Remote Driver
RL7 (8')	8' Type C LED Tube with Remote Driver
RO2 (12")	14W 12" round LED fixture
RO3 (16")	22W 16" round LED fixture
RO4 (20")	32W 20" round LED fixture
RPV1	Replace Roof (for PV system)
RR2	32W 1'x4' recessed LED fixture
RR3	36W 2'x4' recessed LED fixture
RR4	49W 2'x4' recessed LED fixture
RR5	30W 2'x2' recessed LED fixture
RR6	32W 2'x2' surface mounted LED fixture
RS1	8W LED under cabinet
RS1b	11W LED under cabinet
RS2	22W 2' LED surface mounted strip light
RS3	22W 4' LED surface mounted strip light
RS4	32W 4' LED surface mounted strip light
RS6	57W 1'x8' LED surface mounted fixture
RW1	36W 4' LED surface mounted wrap
RW2	47W 4' LED surface mounted wrap
RW3	50W 4' LED wide surface mounted wrap
RW4	25W 2' LED wide surface mounted wrap
V1	18W 2' LED vanity
V2	34W 4' LED vanity
WF1	kitchen aerator replacements (1.5 gpm)
WF2	bathroom aerator replacements (1.0 gpm)
WF3	handheld showerhead replacements (1.5 gpm)
WF4a	tanked toilet flush valve replacement (1.6 gpf)
WF4b	tanked toilet flush valve replacement (1.28 gpf)
WF4c	tankless toilet flush valve replacement (1.6 gpf)
WI	Replace windows with new double-paned vinyl windows at U-0.32 or less
WL1	51W LED flag/sign light
WP2b	28W LED wall pack

WP3b	62W LED wall pack
WP4	25W LED mini wall pack
WP5	9W LED wall sconce
WP6	10W LED Jelly Jar
WP7	9W LED wall pack
WP8	20W LED quarter sphere wall pack
WS1	10W LED wall sconce
X1	LED exit sign

Please refer to complete narrative and specification set for all construction requirements.

2 General Assumptions

Many of the gas and water savings calculations in the investment grade audit use the weather regression of 2016-2017 utility data to quantify baseline energy consumption. This analysis develops an energy use equation that shows the relationship between the aggregate utility data associated with each HUD project number and average daily weather from the baseline period, calculated using a weighted ordinary least squares regression. The energy use equations are then “normalized” using geographically appropriate Typical Meteorological Year weather data to produce projected energy use during a typical weather year pre-Phase 2 retrofit. This typical energy use is separated in to weather dependent and independent components – gas heating, gas baseload, electric heating, electric baseload, electric cooling, domestic water use, and irrigation water use. These are the components that are used as inputs into some savings calculations. Each component value used as a calculation input is stated in the report.

Some of the energy savings calculations have been performed using energy modeling software – the eQuest 3.6 interface for DOE-2.2. It uses an hourly typical weather year and was calibrated to the weather-regressed utility data. This allows all of the different interactions between envelope and heating and cooling systems.

To ensure utility data validation, a thorough audit of Authority records will be performed during the development of the utility baseline.

This type of analysis ensures that savings are based on actual consumption data, as opposed to stipulated savings calculations based on building use assumptions. It is more compatible with an Option C Measurement and Verification Protocol, the preferred approach for this project. In some few cases, baseline adjustments have been proposed to enable an Option C IPMVP approach. Supporting narratives and calculations have been provided in these cases.

When stipulated savings calculation and building use assumptions are employed in this report, such assumptions are clearly stated in the associated Savings Calculations report section.

The measure narratives and specifications that will guide implementation have been designed to support the efficiency performance projected in this audit. Additionally, they will meet or exceed the standards established by San Antonio Housing Authority and applicable Authorities Having Jurisdiction. The following standards have specific relevance to one or more ECMs:

- ASHRAE 90.1
- ASHRAE 62.1 and 62.2
- Illuminating Engineers Society of North America (IESNA) Guidelines
- Environmental Protection Agency (EPA) and Energy Star regulations and standards
- The National Electrical Code (NEC)
- Codes and Standards of the local Authorities Having Jurisdiction

A note on energy savings calculations; in some cases, it is assumed that there will be degradation in energy or water savings over the term of the Phase II EPC. This can be due to decreases in equipment performance over time (before equipment failure), or because of detrimental interaction between ECMs and building users. In these cases, a variance factor has been applied to reduce the projected savings. This is clearly indicated in the relevant calculations presented in this report.

3 Site Descriptions

Below is a table summarizing the properties included in the investment grade energy audit.

AMP	Site #	Site Name	Senior/ Family/ Mixed	Total	Unit Count					
					0	1	2	3	4	5+
TX006000007	TX06-6012.0	Villa Veramendi	Family	166	-	12	62	54	32	6
TX006000011	TX06-6023.0	Sun Park Lane	Senior	65	-	65	-	-	-	-
TX006000011	TX06-6124.0	Frank Hornsby	Senior	59	-	54	55	-	-	-
TX006000012	TX06-6024.0	Mission Park	Family	100	-	8	43	33	10	6
TX006000013	TX06-6026.1	Tarry Towne	Senior	98	-	68	30	-	-	-
TX006000013	TX06-6033.1	Escondida	Senior	20	-	20	-	-	-	-
TX006000013	TX06-6033.3	Williamsburg	Senior	15	-	15	-	-	-	-
TX006000016	TX06-6055.0	Matt Garcia	Senior	55	-	51	4	-	-	-
TX006000017	TX06-6029.0	Blanco	Senior	100	60	36	4	-	-	-
TX006000018	TX06-6030.0	Lewis Chatham	Senior	119	72	42	4	-	-	-
TX006000019	TX06-6026.3	Linda Lou	Senior	4	-	4	-	-	-	-
TX006000019	TX06-6031.0	Riverside Apts	Family	74	-	-	37	37	-	-
TX006000019	TX06-6033.4	Linda Lou	Senior	6	-	6	-	-	-	-
TX006000019	TX06-6040.0	Midway	Senior	20	-	20	-	-	-	-
TX006000020	TX06-6032.1	Madonna	Senior	60	-	36	24	-	-	-
TX006000020	TX06-6032.2	Sahara Ramsey	Senior	16	-	-	16	-	-	-
TX006000021	TX06-6034.0	Cheryl West	Family	82	-	4	38	34	6	-
TX006000021	TX06-6057.0	T. L. Shaley	Family	66	-	10	28	24	4	-
TX006000022	TX06-6038.0	Jewett Circle	Senior	75	-	69	6	-	-	-
TX006000022	TX06-6054.0	Col. Cisneros	Senior	55	-	51	4	-	-	-
TX006000024	TX06-6043.0	Highview Apts	Family	68	-	6	30	28	4	-
TX006000024	TX06-6052.0	William Sinkin	Senior	50	-	45	5	-	-	-
TX006000025	TX06-6044.0	Cross Creek	Family	66	-	5	28	28	5	-
TX006000025	TX06-6049.0	Morris C. Beldon	Family	35	-	6	18	11	-	-
TX006000025	TX06-6056.0	L.C. Rutledge	Family	66	-	10	28	24	4	-
TX006000026	TX06-6047.0	Westway	Family	152	-	22	42	62	26	-
TX006000026	TX06-6051.0	H.B. Gonzalez	Senior	51	-	47	4	-	-	-
TX006000027	TX06-6053.0	Pin Oak II	Family	22	-	4	13	3	2	-
TX006000028	TX06-6058.0	Lila Cockrell	Senior	70	-	65	5	-	-	-
TX006000028	TX06-6130.0	South San	Senior	30	-	30	-	-	-	-
TX006000030	TX06-6129.0	Raymundo Rangel	Senior	26	-	26	-	-	-	-
TX006000030	TX06-6135.0	Mirasol Homes	Family	130	-	-	28	93	6	3

TX006000030	TX06-6137.0	Mirasol Townhomes	Family	24	-	-	15	9	-	-
TX006000030	TX06-6138.0	Mirasol Cottages	Family	20	-	-	20	-	-	-
TX006000030	TX06-6143.0	Christ the King	Senior	48	-	45	3	-	-	-
TX006000031	TX06-6125.0	Spring View Scat.	Family	10	-	-	-	10	-	-
TX006000031	TX06-6136.0	Spring View	Family	111	-	-	84	25	2	-
TX006000031	TX06-6140.0	Spring View Sr.	Senior	40	-	40	-	-	-	-
TX006000054	TX06-6054.1	Pin Oak I	Senior	50	12	36	2	-	-	-
Total				2324	144	958	680	475	101	15

Blanco

Number of Units: 100
Construction Date: 1971
Senior Housing
Number of Stories: 4
Bedroom Distribution: 60 studio, 36 1-bedroom, 4 2-bedroom

Building Envelope

Blanco is a senior site that is comprised of a four story elevator building. The building has double pane windows with aluminum frames, and flat roofs.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Blanco consists of a mix of incandescent and compact fluorescent wall sconces throughout the bedrooms and living rooms. The kitchens have a 4' 40W T12 linear fluorescent recessed ceiling fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs, pole lights, sconces, and canopy lights.

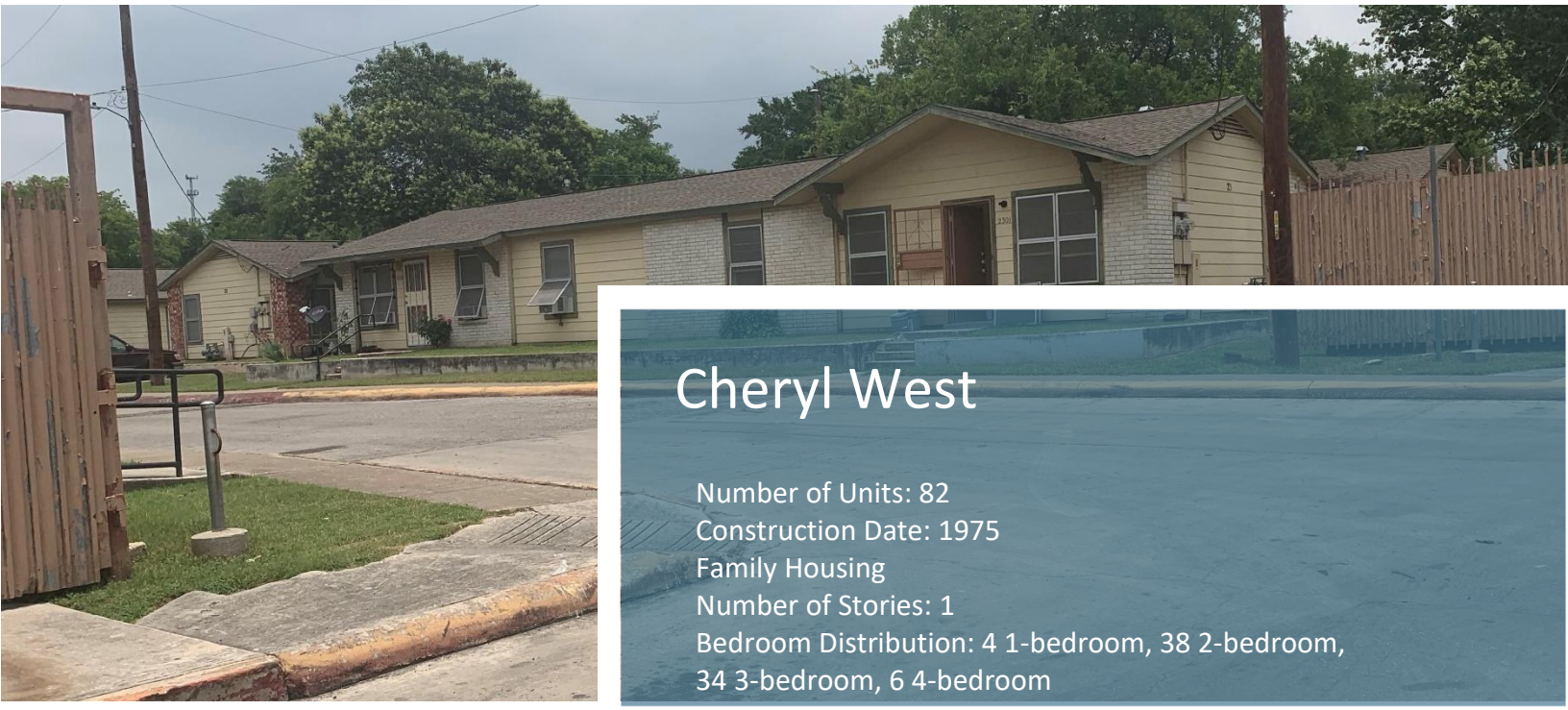
HVAC

Heating: The building is heated by (2) natural gas Raypak boilers (1,260 Mbtuh input, 82% efficiency) with barometric dampers. The heating and cooling systems are primary-secondary, and operate with a two pipe system that serves fan coil units in each residential unit. The system is manually changed over in mid-November and mid-February.

Cooling: There is also a York scroll chiller with BAC cooling tower to provide cooling.

DHW: Domestic hot water (DHW) is provided by (1) atmospheric, natural gas Raypak boiler (511 Mbtuh) serving a storage tank.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.



Cheryl West

Number of Units: 82
Construction Date: 1975
Family Housing
Number of Stories: 1
Bedroom Distribution: 4 1-bedroom, 38 2-bedroom, 34 3-bedroom, 6 4-bedroom

Building Envelope

Cheryl West is a family site comprised of a one story duplexes and detached homes. The units have single pane windows with aluminum frames, wood-framed walls, and a sloped, shingled roof with 3" of blown-in cellulose insulation.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Cheryl West consists of ceiling mounted fixtures in the bedrooms, hallways, kitchens, and living rooms, with a mix of incandescent and compact fluorescent bulbs. The bathrooms have a vanity fixture with incandescent bulbs. The kitchens have a linear fluorescent fixture with 17W T8 lamps.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs and flood lights.

HVAC

Heating: The units are heated by in-unit natural gas furnaces (50 MBH input, 80% efficiency).

Cooling: Cooling is provided by tenant-owned window AC units.

DHW: Domestic hot water (DHW) is provided by individual natural gas packaged hot water heaters.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Christ the King

Number of Units: 48
Construction Date: 1998
Senior Housing
Number of Stories: 1-2
Bedroom Distribution: 45 1-bedroom, 3 2-bedroom

Building Envelope

Christ the King is a senior site that is comprised of a mix of row-type homes and a two-story walkup. The homes have double pane windows with aluminum frames, and pitched, shingled roofs. The buildings are wood frame construction with some batt insulation.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Christ the King consists of primarily incandescent and compact fluorescent ceiling mounted fixtures throughout the bedrooms, hallways, and living rooms. The kitchens have a 40W T12 linear fluorescent ceiling fixture. The bathrooms have a 20W T12 linear fluorescent vanity fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs, pole lights, and canopy lights.

HVAC

Heating: The units at Christ the King are each heated with electric resistance heating located in the ceiling in each unit.

Cooling: The units at Christ the King are cooled with a split AC system. There are a variety of R-22 condensing units serving these systems.

DHW: Domestic hot water (DHW) is provided by an electric 30-40 gallon DHW heater per unit; there are a variety of models present.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Col. Cisneros

Number of Units: 55
Construction Date: 1976
Senior Housing
Number of Stories: 1
Bedroom Distribution: 51 1-bedroom, 4 2-bedroom

Building Envelope

Col Cisneros is a senior site that is comprised of one story rowhomes. The units have single pane windows with aluminum frames, wood-framed walls with a brick exterior, and a sloped, shingled roof with an assumed R value of 30.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Col. Cisneros consists of ceiling mounted fixtures, with primarily incandescent bulbs, in the bedrooms, living rooms, hallways, and kitchens. The bathrooms each have a wall sconce and a recessed ceiling fixture, also with incandescent bulbs. A few kitchens have ceiling mounted linear fluorescent fixtures.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs and pole lights.

HVAC

Heating: The units are heated by individual split air-cooled heat pumps. The thermostats are digital, non-programmable thermostats.

Cooling: The units are cooled by individual split air-cooled heat pumps.

DHW: Domestic hot water (DHW) is provided by individual electric packaged hot water heaters.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Cross Creek

Number of Units: 66
Construction Date: 1977
Family Housing
Number of Stories: 2
Bedroom Distribution: 5 1-bedroom, 28 2-bedroom, 28 3-bedroom, 5 4-bedroom

Building Envelope

Cross Creek is a family site comprised of a two story rowhomes. The units have double pane windows with aluminum frames, wood-framed walls with a brick façade, and a sloped, shingled roof with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Cross Creek consists of ceiling mounted fixtures in the bedrooms, living rooms, and kitchens, with primarily incandescent bulbs. The hallways have an incandescent wall sconce, and the bathrooms have incandescent vanity fixtures. There are T12 linear fluorescent ceiling fixtures in the kitchen.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs, sconces, and pole lights.

HVAC

Heating: The units are heated by individual natural gas furnaces. There are a variety of models present, but the majority of units have 60 MBH input GE furnaces.

Cooling: Cooling is provided by tenant-owned window AC units.

DHW: Domestic hot water (DHW) is provided by individual natural gas packaged hot water heaters. A variety of models are present, ranging from 29 to 40 gallon tanks.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Escondida

Number of Units: 20
Construction Date: 1971
Senior Housing
Number of Stories: 2
Bedroom Distribution: 20 1-bedroom

Building Envelope

Escondida is a senior site that is comprised of a two story walk-up building. The units have single pane windows with aluminum frames, wood-framed walls, and a sloped, shingled roof with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The bedrooms and living rooms are lit by ceiling mounted fixtures with predominantly incandescent bulbs. The kitchens have T12 linear fluorescent fixtures and ceiling pendants with incandescent bulbs. The bathrooms have a wall mounted linear fluorescent fixture, and an additional ceiling fixture with an incandescent bulb. Some units have a wall sconce in the hallway with a mix of CFL and incandescent bulbs.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs, sconces, ceiling fixtures, and car port lights.

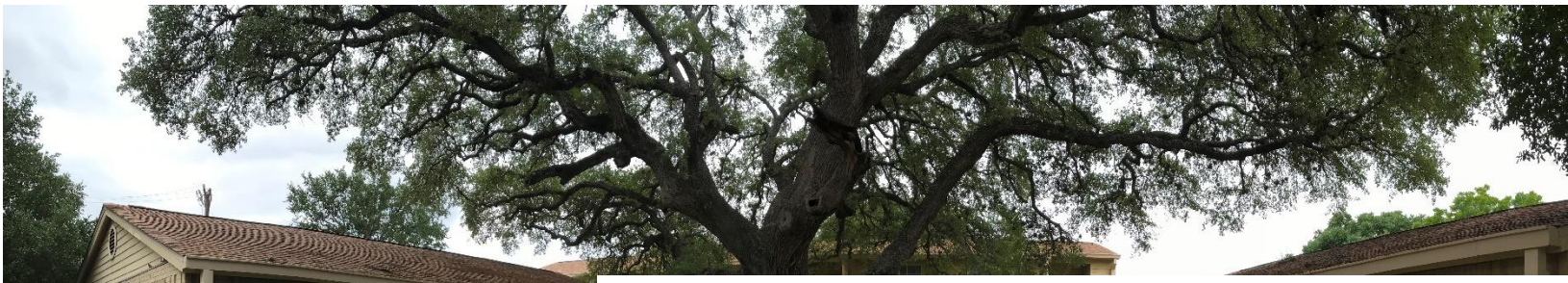
HVAC

Heating: The units are heated by individual natural gas furnaces. There are a variety of furnace models present.

Cooling: DX cooling provided by a split condensing unit. Some of the condensing units use R-22 and some use R-410a. The thermostats are analog, non-programmable thermostats.

DHW: Domestic hot water (DHW) is provided by (2) central, packaged hot water heaters. One heater is a Rheem Fury 40 MBH input heater with a 40 gallon capacity, and the other is a RUUD 199 MBH input heater with a 91 gallon capacity.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.



Frank Hornsby

Number of Units: 59
Construction Date: 1985
Senior Housing
Number of Stories: 1-2
Bedroom Distribution: 54 1-bedroom, 5 2-bedroom

Building Envelope

Frank Hornsby is a senior site comprised of one and two story walk-ups. The units have double pane windows with aluminum frames, wood-framed walls with a brick façade, and a sloped, shingled roof with an assumed R value of 30.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Frank Hornsby consists of primarily incandescent and compact fluorescent ceiling mounted fixtures throughout the bedrooms and living rooms. The kitchens have a 4' 40W T12 linear fluorescent ceiling mounted fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs, sconces, flag lights, and pole lights.

HVAC

Heating: The units are heated by individual electric resistance heaters.

Cooling: DX cooling provided by a split condensing unit.

DHW: Domestic hot water (DHW) is provided by individual Rheem electric packaged hot water heaters (30 gallons for 1 bedroom units, 40 gallons for 2 bedroom units).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

HB Gonzalez

Number of Units: 51
Construction Date: 1980
Senior Housing
Number of Stories: 3
Bedroom Distribution: 47 1-bedroom, 4 2-bedroom

Building Envelope

H.B. Gonzalez is a senior site, consisting of one three story walk-up building. The building has double pane windows with aluminum frames, and a sloped, shingled roof with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at H.B. Gonzalez consists of primarily incandescent and compact fluorescent ceiling mounted fixtures, and wall sconces throughout the bedrooms, living rooms, and hallways. The kitchens have both 4' ceiling fixtures and 2' fixtures above the sinks. The bathrooms have both an incandescent vanity fixture and a can light.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, ceiling fixtures, and pole lights.

HVAC

Heating: The units are heated by split-system air cooled heat pumps with R-22 or R-410A condensing units, ranging in tonnage depending on the unit size.

Cooling: DX cooling provided by the split-system heat pumps.

DHW: Domestic hot water (DHW) is provided by (3) central, natural gas packaged hot water heaters (199 MBH input, 100 gallons each), which are served by (2) 1/12 HP recirculation pumps.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Highview Apartments

Number of Units: 68
Construction Date: 1986
Family Housing
Number of Stories: 1
Bedroom Distribution: 6 1-bedroom, 30 2-bedroom, 28 3-bedroom, 4 4-bedroom

Building Envelope

Highview is a family site comprised of one story duplexes. The units have single pane windows with aluminum frames, wood-framed walls with a brick exterior, and a sloped, shingled roof with an assumed R value of 30.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Highview consists of primarily incandescent and compact fluorescent ceiling mounted fixtures throughout the bedrooms, kitchens, hallways, and living rooms. The bathrooms have incandescent vanity fixtures. Each unit has (2) wall mounted porch lights with incandescent bulbs.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, and pole lights.

HVAC

Heating: The units are heated by individual natural gas furnaces (80% efficiency); a variety of models are present.

Cooling: Cooling is provided by tenant-owned window AC units.

DHW: Domestic hot water (DHW) is provided by individual natural gas packaged hot water heaters (40-75 gallon capacity; 38-75 MBH input, depending on unit size).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Jewett Circle

Number of Units: 75
Construction Date: 1976
Senior Housing
Number of Stories: 3
Bedroom Distribution: 69 1-bedroom, 6 2-bedroom

Building Envelope

Jewett Circle is a senior site that is comprised of three story walk-up building. The building has single pane windows with aluminum frames, and a sloped, shingled roof with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Jewett Circle consists of primarily incandescent and compact fluorescent wall sconce fixtures throughout the bedrooms, hallways, and living rooms. The kitchens have a 4' ceiling fixture. The bathrooms have an incandescent vanity fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, and pole lights.

HVAC

Heating: The units are heated by natural gas furnaces, controlled by non-programmable thermostats. The furnaces ranged from 40 MBH input to 50 MBH input, with a variety of models throughout the units.

Cooling: DX cooling provided by a split condensing unit. There are a variety of condensing units.

DHW: Domestic hot water (DHW) is provided by (3) central, natural gas packaged hot water heaters (199 MBH input, 100 gallons each). The heaters are served by a 1/12 HP recirculation pump.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

LC Rutledge

Number of Units: 66
Construction Date: 1976
Family Housing
Number of Stories: 1
Bedroom Distribution: 10 1-bedroom, 28 2-bedroom, 24 3-bedroom, 4 4-bedroom

Building Envelope

L.C. Rutledge is a family site that is comprised of one story semi-detached homes. The units have double pane windows with aluminum frames, wood-framed walls with brick exterior, and sloped,

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at L.C. Rutledge consists of ceiling mounted fixtures in the bedrooms, kitchens, living rooms, and hallways, with primarily incandescent bulbs. The bathrooms have vanity fixtures with incandescent bulbs, and most units have a T12 linear fluorescent fixture in the kitchen.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, and pole lights.

HVAC

Heating: The units are heated by individual natural gas furnaces, ranging from 50 to 65 MBH input; a variety of models were present.

Cooling: Cooling is provided by resident-owned window AC units.

DHW: Each unit has a natural gas, packaged domestic hot water (DHW) heater, ranging from 28 to 40 gallons in capacity. A variety of models were present.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Lewis Chatham

Number of Units: 119
Construction Date: 1971
Senior Housing
Number of Stories: 4
Bedroom Distribution: 72 studio, 42 1-bedroom, 4 2-bedroom, 1 3-bedroom

Building Envelope

Lewis Chatham is a senior site comprised of a four story apartment building. The building has double pane windows with aluminum frames, and a flat roof with an assumed R value of 8.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Lewis Chatham consists of primarily incandescent and compact fluorescent ceiling mounted fixtures throughout the bedrooms, living rooms, and kitchens. The kitchens also have a 13W T5 linear fluorescent undercabinet fixture. The bathrooms have both an incandescent recessed fixture and a T12 linear fluorescent vanity fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs, entry strip fixtures, a jelly jar, and pole lights.

HVAC

Heating: The units are individually heated by a variable refrigerant flow system, with R-410A central condensing units on the roof and serving individual Daikin heat pumps in each unit. The heat pumps are controlled by digital, programmable thermostats.

Cooling: The units are also cooled by the heat pumps.

DHW: Domestic hot water (DHW) is provided by (2) central, A.O. Smith natural gas packaged hot water heaters (199 MBH input, 100 gallons each), which are supplemented with an A.O. Smith DHW 350 gallon storage tank and a recirculation pump.

Ventilation: Exhaust is provided by centrally vented bath fans. Ventilation is provided by operable windows.

Lila Cockrell

Number of Units: 70
Construction Date: 1982
Senior Housing
Number of Stories: 3
Bedroom Distribution: 65 1-bedroom, 5 2-bedroom

Building Envelope

Lila Cockrell is a senior site that is comprised of a three story walk-up building. The building has double pane windows with aluminum frames, wood-framed walls with brick exterior, and a sloped, shingled

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Lila Cockrell consists of ceiling mounted fixtures with a mix of incandescent and compact fluorescent (CFL) bulbs, throughout the bedrooms, kitchens, living rooms, and hallways. The bathrooms each have a vanity fixture incandescent bulbs. Most units have a 2' T12 linear fluorescent fixture in the kitchen.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, and pole lights.

HVAC

Heating: The units are heated by split electric resistant heating systems. The unit temperatures are controlled by analog, non-programmable thermostats in each unit.

Cooling: DX cooling provided by a split condensing unit. There are a variety of condensing units.

DHW: Domestic hot water (DHW) is provided by (2) central Raypak hot water boilers (511 MBH each, 80% efficiency), which serve a storage tank. There is a 1/12 HP DHW recirculation pump and (2) boiler pumps (1/2 HP and 3/4 HP).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Linda Lou

Number of Units: 10
Construction Date: 1969
Senior Housing
Number of Stories: 1
Bedroom Distribution: 10 1-bedroom

Building Envelope

Linda Lou is a senior site that is comprised of row-type homes. The homes have single pane windows with aluminum frames, and pitched, shingled roofs with an assumed R-value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Linda Lou consists of primarily incandescent and compact fluorescent ceiling mounted fixtures throughout the bedrooms, and living rooms. The kitchens have a 4' linear fluorescent and the bathrooms also have a 2' linear fluorescent vanity fixture. Each unit has (2) wall mounted porch lights with incandescent bulbs.

Exterior Lighting Technology Type: The common area lighting is provided by screw-in bulbs. Exterior lighting consists of wall packs.

HVAC

Heating: The units at Linda Lou are each heated with a natural gas wall furnace in the living room of each unit.

Cooling: Tenant-provided window AC units provide cooling.

DHW: Domestic hot water (DHW) is provided by a natural gas 40 gallon DHW heater per unit; there are a variety of models present.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Madonna

Number of Units: 60
Construction Date: 1962
Senior Housing
Number of Stories: 2
Bedroom Distribution: 36 1-bedroom, 24 2-bedroom

Building Envelope

Madonna is a senior site comprised of (9) two story walk-up buildings. The units have single pane windows with aluminum frames, and pitched, shingled roofs with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Madonna consists of primarily incandescent and compact fluorescent ceiling mounted fixtures, wall sconces, pendant lights, and ceiling fans throughout the bedrooms, living rooms, hallways, and kitchens. The bathrooms have compact fluorescent or incandescent vanity fixtures.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, bollards, car port lights, and pole lights.

HVAC

Heating: The units are heated by individual natural gas furnaces (60-66 MBH input, 90% efficiency). The furnaces are controlled by non-programmable thermostats.

Cooling: DX cooling provided by a split condensing unit. There are a variety of condensing units.

DHW: Domestic hot water (DHW) is provided by a Raypak natural gas boiler (750 MBH input, 80% efficiency), which serves a 115 gallon Raypak storage tank. There is a ½ HP pump that serves the boiler, and a Bell & Gossett recirculation pump.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Matt Garcia

Number of Units: 55
Construction Date: 1984
Senior Housing
Number of Stories: 3
Bedroom Distribution: 51 1-bedroom, 4 2-bedroom

Building Envelope

Matt Garcia is a senior site that is comprised of apartment buildings with exterior walkways. The homes have double pane windows with aluminum frames, and pitched, shingled roofs with an assumed R value of 11. The buildings are wood frame construction with some batt insulation.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Matt Garcia consists of primarily incandescent and compact fluorescent ceiling mounted fixtures throughout the bedrooms, hallways, and living rooms. The bathrooms have an incandescent vanity fixture and ceiling fixture. The kitchens have a 40W T12 linear fluorescent ceiling fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, and flood lights.

HVAC

Heating: The units at Matt Garcia are each heated with a split air-cooled heat pump system located in the ceiling in each unit. There are 8.5 HSPF Carrier R-410a condensing units serving these systems.

Cooling: DX cooling provided by the split heat pumps with 15 SEER condensing units.

DHW: Domestic hot water (DHW) is provided by an electric 30-40 gallon electric DHW heater per unit.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Midway

Number of Units: 20
Construction Date: 1976
Senior Housing
Number of Stories: 1
Bedroom Distribution: 20 1-bedroom

Building Envelope

Midway is a senior site that is comprised of one story row homes. The homes have double pane windows with aluminum frames, and pitched, shingled roofs with an assumed R value of 11. The buildings are wood frame construction with some batt insulation.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Midway consists of primarily incandescent and compact fluorescent ceiling and wall mounted fixtures throughout the bedrooms, hallways, and kitchens.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of ceiling fixtures, wall packs, and flood lights.

HVAC

Heating: The units at Midway are each heated by a pressurized, natural gas Ruud furnace (50 Mbtuh input).

Cooling: DX cooling provided by a split condensing unit. There are a variety of condensing units.

DHW: Domestic hot water (DHW) is provided by a natural gas packaged DHW heater with an insulated cover.
Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Mirasol

Number of Units: 174
Construction Date: 1952 (rehabbed 2000-2003)
Family Housing
Number of Stories: 1-2
Bedroom Distribution: 63 2-bedroom, 102 3-bedroom, 6 4-bedroom, 3 5-bedroom

Building Envelope

Mirasol is made up of Mirasol Homes (130 units), Mirasol Townhomes (24 units), and Mirasol Cottages (20 units). The units have double pane windows with aluminum frames, wood-framed walls, and sloped, shingled roofs with 9” of batt insulation, for an assumed R value of 29.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Mirasol consists of ceiling mounted fixtures in the living rooms, bedrooms, hallways, and some kitchens, with predominantly incandescent bulbs. Bathrooms have vanity fixtures, also with predominantly incandescent bulbs. A few units have 2’ T12 vanity fixtures instead. The kitchens each have a linear fluorescent fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of flood lights, canopy lights, wall packs, and pole lights.

HVAC

Heating: The units are heated by individual split air-cooled heat pump systems, served by R-22 condensing units. A variety of models are present. The heat pump systems are controlled by digital, programmable thermostats.

Cooling: DX cooling provided by the split condensing unit. There are a variety of condensing units.

DHW: Domestic hot water (DHW) is provided by a 30-40 gallon electric packaged heater in each unit; the rowhomes each had a 4.5 or 5.5 MBH input State heater, and the single family homes had either a 5.5 MBH input A.O. Smith heater or a 4.5 MBH input Bradford White heater.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Mission Park

Number of Units: 100
Construction Date: 1971
Family Housing
Number of Stories: 1-2
Bedroom Distribution: 8 1-bedroom, 43 2-bedroom, 33 3-bedroom, 10 4-bedroom, 6 5-bedroom

Building Envelope

Mission Park is a family site comprised of one and two story rowhomes. The units have single pane windows with aluminum frames, wood-framed walls, and pitched, shingled roofs with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Mission Park consists of primarily incandescent and compact fluorescent ceiling mounted fixtures throughout the bedrooms, hallways, and living rooms. The kitchens have a 4' 40W T12 linear fluorescent ceiling mounted fixture. The bathrooms have an incandescent vanity fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of flood lights, wall packs, and pole lights.

HVAC

Heating: The units are heated by individual split-system air cooled heat pumps, with a variety of condensing units. The heat pumps are controlled by digital, programmable thermostats.

Cooling: DX cooling provided by a split heat pump condensing units.

DHW: Domestic hot water (DHW) is provided by individual Ruud electric packaged hot water heaters (30-50 gallons, depending on unit size).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

MC Beldon

Number of Units: 35
Construction Date: 1981
Family Housing
Number of Stories: 1-2
Bedroom Distribution: 6 1-bedroom, 18 2-bedroom, 11 3-bedroom

Building Envelope

Morris C. Beldon is a family site that is comprised of one and two story townhomes. The units have double pane windows with aluminum frames, wood-framed walls, and sloped, shingled roofs with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at MC Beldon consists of surface mounted fixtures throughout the hallways, kitchens, and bedrooms, with incandescent or compact fluorescent (CFL) bulbs. The bathrooms each have a vanity fixture with CFL or incandescent bulbs. The kitchens each have a 4' T12 linear fluorescent fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces and wall packs.

HVAC

Heating: The units are heated by individual natural gas furnaces (45 MBH to 80 MBH input, depending on unit size). A variety of models are present. The furnaces are controlled by analog, non-programmable thermostats.

Cooling: Cooling is provided by window air conditioning units.

DHW: Domestic hot water (DHW) is provided by individual packaged heaters. The one bedroom units have 28-30 gallon natural gas heaters, and the rest of the property has 40 gallon electric heaters, with a range of heater models.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Pin Oaks I

Number of Units: 50
Construction Date: 1979
Senior Housing
Number of Stories: 3
Bedroom Distribution: 12 studio, 36 1-bedroom, 2 2-bedroom

Building Envelope

Pin Oaks I is a senior site that is comprised of a three-story apartment building with exterior walkways. The homes have single pane windows with aluminum frames, and pitched, shingled roofs with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Pin Oaks I consists of primarily incandescent wall mounted fixtures throughout the bedrooms, hallways, and living rooms. The bathrooms have an incandescent vanity fixture and the kitchens have either a 40W T12 linear fluorescent ceiling fixture or an incandescent ceiling fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, ceiling fixtures, and pole lights.

HVAC

Heating: The units at Pin Oaks I are each heated by an atmospheric, natural gas General Electric furnace (60 Mbtuh input).

Cooling: Cooling is provided by through-the-wall AC units.

DHW: Domestic hot water (DHW) is provided by a two central packaged tank natural gas Rheem water heaters (200 Mbtuh input, 97 gallon capacity).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Pin Oaks II

Number of Units: 22
Construction Date: 1979
Family Housing
Number of Stories: 1
Bedroom Distribution: 4 1-bedroom, 13 2-bedroom, 3 3-bedroom, 2 4-bedroom

Building Envelope

Pin Oaks II is a family site that is comprised of single story row-type homes. The homes have double pane windows with aluminum frames, and pitched, shingled roofs with an assumed R value of 11. The buildings are wood frame construction with some batt insulation.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Pin Oaks II consists of primarily incandescent ceiling mounted fixtures throughout the bedrooms, hallways, and living rooms. The bathrooms have an incandescent vanity fixture. Some kitchens have a 40W T12 linear fluorescent ceiling fixture, but most have an incandescent ceiling fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, a flag light, and pole lights.

HVAC

Heating: The units at Pin Oaks II are each heated by an atmospheric, natural gas furnace; there are a variety of models present.

Cooling: Cooling is provided by window air conditioners.

DHW: Domestic hot water (DHW) is provided by a natural gas 40 gallon DHW heater per unit; there are a variety of models present.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Raymundo Rangel

Number of Units: 26
Construction Date: 2000
Senior Housing
Number of Stories: 1
Bedroom Distribution: 26 1-bedroom

Building Envelope

Raymundo Rangel is a senior site that is comprised of one story rowhomes. The units have double pane windows with vinyl frames, wood-framed walls, and sloped, shingled roofs with an assumed R value of 16.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Raymundo Rangel consists of ceiling fans in the bedrooms and living rooms, vanity fixtures in the bathrooms, and ceiling mounted fixtures in the hallways, with predominantly incandescent bulbs. The kitchens each have a 4' 2-lamp T12 ceiling fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of flood lights, wall packs, and pole lights.

HVAC

Heating: The units are heated by split-system air cooled heat pumps, served by a mix of R-22 and R-410A condensing units. The heat pumps are controlled by digital, non-programmable thermostats.

Cooling: DX cooling provided by the heat pumps. There are a variety of condensing units.

DHW: Domestic hot water (DHW) is provided by individual electric packaged hot water heaters (30-38 gallons).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Riverside Apartments

Number of Units: 74
Construction Date: 1976
Family Housing
Number of Stories: 2
Bedroom Distribution: 37 2-bedroom, 37 3-bedroom

Building Envelope

Riverside is a family site that is comprised of two story rowhomes. The units have single pane windows with aluminum frames, wood-framed walls, and sloped, shingled roofs with 4" of batt insulation, for an assumed R value of 13.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Riverside consists of ceiling mounted fixtures in the living rooms, kitchens, hallways, bathrooms and bedrooms, with a mixture of compact fluorescent (CFL) and incandescent bulbs. The bathrooms and hallways also have wall mounted fixtures, and the kitchens each have a T12 linear fluorescent ceiling mounted fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, and flood lights.

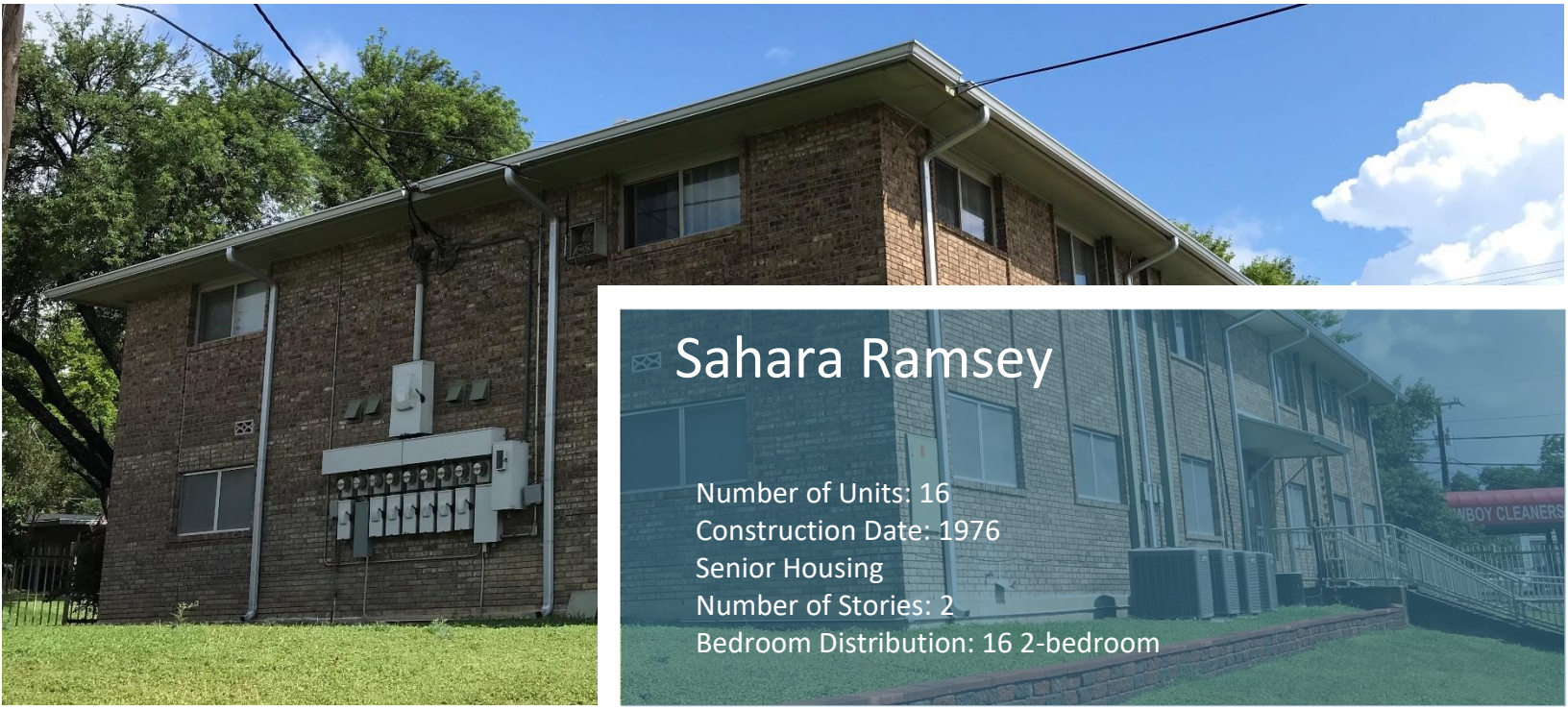
HVAC

Heating: The units are heated by individual natural gas furnaces (80% efficiency, 50-66 MBH input). The furnaces are controlled by digital, programmable thermostats.

Cooling: DX cooling provided by a split condensing unit. There are a variety of R-22 condensing units.

DHW: Domestic hot water (DHW) is provided by individual natural gas packaged hot water heaters with a 40 gallon capacity (38-40 MBH input). A variety of models are present, predominantly Rheem.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.



Sahara Ramsey

Number of Units: 16
Construction Date: 1976
Senior Housing
Number of Stories: 2
Bedroom Distribution: 16 2-bedroom

Building Envelope

Sahara Ramsey is a senior site that is comprised of (2) two story walk-up buildings. The buildings have single pane windows with aluminum frames, wood-framed walls, and sloped, shingled roofs with an assumed R value of 16

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Sahara Ramsey consists of ceiling mounted fixtures in the bedrooms, hallways, living rooms, and kitchens, with predominantly incandescent bulbs. There is a vanity fixture with incandescent bulbs in each bathroom.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs and flag lights.

HVAC

Heating: The units are heated by individual natural gas Goodman furnaces (45 MBH input, 80% efficiency).

Cooling: DX cooling provided by a split condensing unit. The condensing units are predominantly Lennox 2 ton units with R-410A.

DHW: Domestic hot water (DHW) is provided by (2) central packaged hot water heaters, one per building. The heaters are each 75 gallons and 75 MBH input, and served by 1/12 HP DHW recirculation pumps.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

South San

Number of Units: 30
Construction Date: 1983
Senior Housing
Number of Stories: 1
Bedroom Distribution: 30 1-bedroom

Building Envelope

South San is a senior site that is comprised of one story rowhomes. The buildings have double pane windows with vinyl frames, wood-framed walls, and sloped, metal roofs with an assumed R value of 10.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at South San consists of ceiling mounted fixtures in the bedrooms and living rooms, and wall mounted fixtures in the bathrooms, with a mix of incandescent and compact fluorescent (CFL) bulbs. The bedroom closets have wall mounted 2' T12 linear fluorescent fixtures, and the kitchens each have a 4' T12 linear fluorescent fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of flag lights, wall packs, and pole lights.

HVAC

Heating: The units are heated by individual York electric resistance heaters (4.5 kW).

Cooling: DX cooling provided by a split condensing unit. There are a variety of R-22 condensing units.

DHW: Domestic hot water (DHW) is provided by individual electric packaged hot water heaters with a 30 gallon capacity.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Spring View

Number of Units: 161
Construction Date: 2004 (Senior), 2006 (Townhomes), 1998 (Apartment)
Family and Senior Housing
Number of Stories: 1-3
Bedroom Distribution: 40 (Senior), 111 (Townhomes), 10 (Apartment)

Building Envelope

Spring View's senior site is comprised of 1 story rowhomes. The homes have double paned windows with aluminum frames, and pitched, shingled roofs. The buildings are wood frame construction with some batt insulation and a brick façade.
Spring View's apartment building is three stories, with concrete masonry unit construction and a sloped, standing seam metal roof. Units have double paned windows with wood frames.
Spring View's townhomes have double paned windows with metal frames, and pitched, shingled roofs with an assumed R value of 16.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Spring View consists of primarily incandescent and compact fluorescent ceiling fixtures, sconces, can lights, and ceiling fans throughout the bedrooms, hallways, and living rooms. The kitchens have a 4' ceiling fixture. The bathrooms have an incandescent vanity fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs, pin-based, and linear fluorescents. Exterior lighting consists of sconces, wall packs, and pole lights.

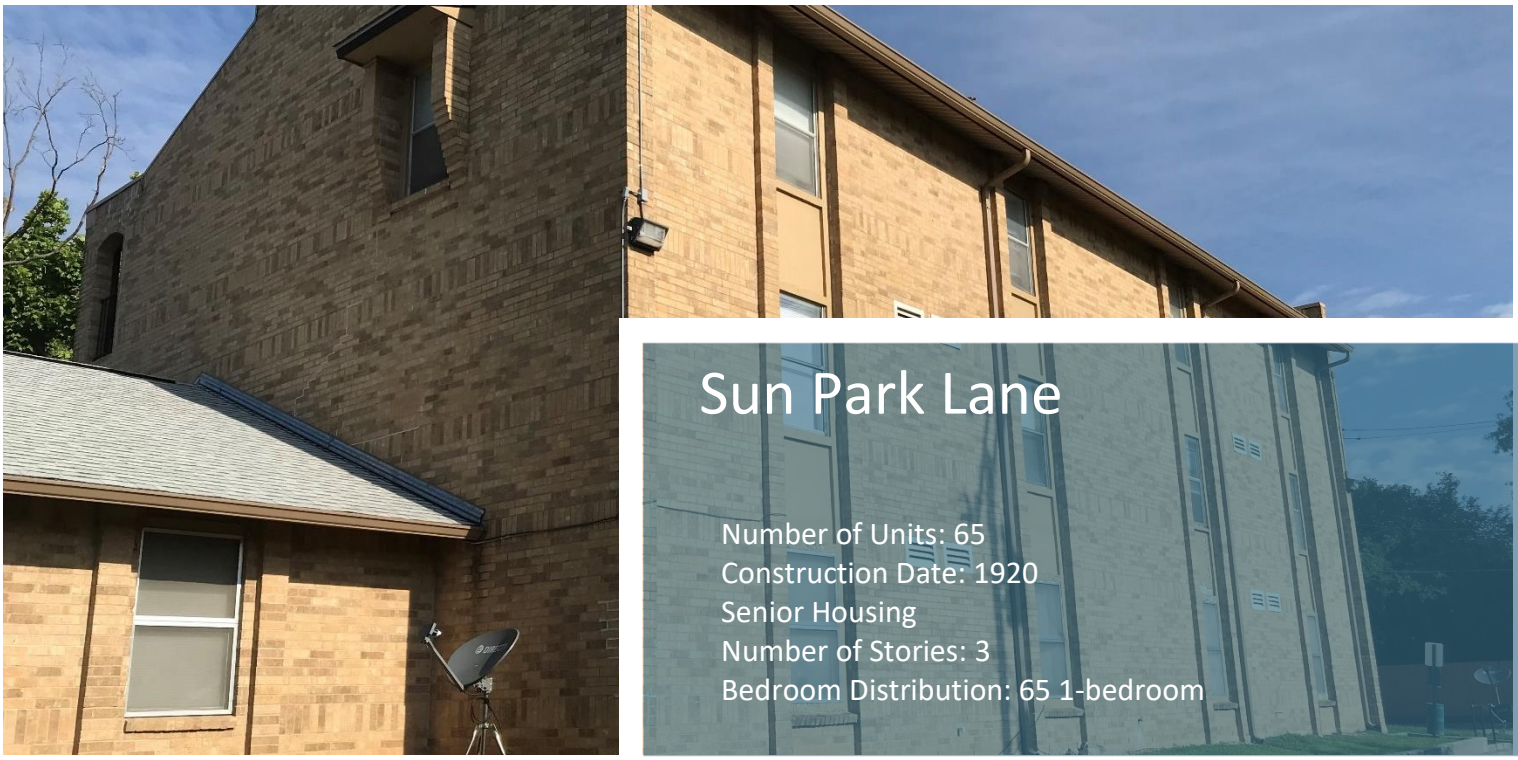
HVAC

Heating: The units are heated by split-system air cooled heat pumps, served by a mix of condensing units. The heat pumps are controlled by digital, non-programmable thermostats.

Cooling: DX cooling provided by the heat pumps. There are a variety of condensing units.

DHW: Domestic hot water (DHW) is provided by individual electric, packaged domestic hot water (DHW) heaters (30-50 gallon capacity, depending on unit size).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.



Sun Park Lane

Number of Units: 65
Construction Date: 1920
Senior Housing
Number of Stories: 3
Bedroom Distribution: 65 1-bedroom

Building Envelope

Sun Park Lane is a senior site comprised of a three story walk-up building. The units have double pane windows with aluminum frames, wood-framed walls, and a sloped, shingled roof with little to no insulation.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Sun Park Lane consists of primarily compact fluorescent and incandescent wall mounted fixtures throughout the bedrooms, bathrooms, and living rooms. There are compact fluorescent and incandescent ceiling mounted fixtures in the kitchens and hallways.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, canopy lights, wall packs, and pole lights.

HVAC

Heating: The units are heated by individual General Electric natural gas furnaces (60 MBH input, 80% efficiency).

Cooling: Cooling is provided by through-the-wall PTAC units (9.7 EER).

DHW: Domestic hot water (DHW) is provided by (3) central natural gas packaged hot water heaters (199 MBH input, 100 gallons each), which are served by a recirculation pump.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

TL Shaley

Number of Units: 66
Construction Date: 1982
Family Housing
Number of Stories: 1
Bedroom Distribution: 10 1-bedroom, 28 2-bedroom, 24 3-bedroom, 4 4-bedroom

Building Envelope

T.L. Shaley is a family site comprised of one story duplexes. The units have single pane windows with aluminum frames, wood-framed walls with a brick exterior, and a sloped, shingled roof with 3" of blown-in cellulose insulation.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at T.L. Shaley consists of primarily compact fluorescent or incandescent ceiling mounted fixtures throughout the bedrooms, living rooms, hallways, and kitchens. Most kitchens have a 2' 17W T8 linear fluorescent ceiling mounted fixture. The bathrooms have incandescent vanity fixtures.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, wall packs, and flood lights.

HVAC

Heating: The units are heated by individual natural gas furnaces (50-75 MBH input, 80% efficiency). A variety of models are present.

Cooling: Cooling is provided by window air conditioning units.

DHW: Domestic hot water (DHW) is provided by individual natural gas packaged hot water heaters (30-40 gallon capacity).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Tarry Towne

Number of Units: 98
Construction Date: 1969
Senior Housing
Number of Stories: 2
Bedroom Distribution: 68 1-bedroom, 30 2-bedroom

Building Envelope

Tarry Towne is a senior site comprised of two story walk-up buildings. The units have single pane windows with aluminum frames, wood-framed walls with a brick façade, and a sloped, shingled roof with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Tarry Towne consists of primarily compact fluorescent and incandescent ceiling mounted fixtures and wall sconces throughout the bedrooms, hallways, living rooms, and kitchens. Kitchens have a 4' 40W T12 linear fluorescent. The bathrooms have a incandescent vanity fixture or.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of sconces, ceiling fixtures, wall packs, and flood lights.

HVAC

Heating: The units are heated by individual natural gas furnaces (40-45 MBH input, 80% efficiency). The furnaces are controlled by non-programmable thermostats.

Cooling: DX cooling provided by a split condensing unit. There are a variety of condensing units.

DHW: Domestic hot water (DHW) is provided by central natural gas packaged hot water heaters (199 MBH input, 100 gallon capacity each). There is (1) DHW heater per building, for a total of 8.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Villa Veramendi

Number of Units: 166
Construction Date: 1952
Family Housing
Number of Stories: 2
Bedroom Distribution: 12 1-bedroom, 62 2-bedroom, 54 3-bedroom, 32 4-bedroom, 6 5-bedroom

Building Envelope

Villa Veramendi is a family site that is comprised of two story row homes. The homes have double pane windows with aluminum frames, and pitched, shingled roofs with an assumed R value of 13. The buildings are wood frame construction with some batt insulation.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Villa Veramendi consists of primarily incandescent and compact fluorescent fan and ceiling mounted fixtures throughout the bedrooms, hallways, and living rooms. The kitchens have a 4' linear fluorescent ceiling fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of flood lights, wall packs, and pole lights.

HVAC

Heating: The units at Villa Veramendi are each heated with a split air-cooled heat pump system located in a closet in each unit. There are 7.5 HSPF Carrier R-22 condensing units serving these systems.

Cooling: DX cooling provided by the 12 SEER split condensing unit.

DHW: Domestic hot water (DHW) is provided by an electric 50 gallon AO Smith DHW heater per unit.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Westway

Number of Units: 152
Construction Date: 1961
Family Housing
Number of Stories: 2
Bedroom Distribution: 22 1-bedroom, 42 2-bedroom, 62 3-bedroom, 26 4-bedroom

Building Envelope

Westway is a family site that is comprised of two story walk-up buildings. The buildings have double pane windows with aluminum frames, wood-framed walls, and sloped, shingled roofs with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Westway consists of ceiling mounted fixtures in the bedrooms and bathrooms, and in the living rooms of 4 bedroom units. The hallways have wall fixtures, and in the 1-3 bedroom units, there is a pendant fixture in the kitchen. Fixtures have a mix of incandescent and compact fluorescent (CFL) bulbs. Each kitchen also has a T12 linear fluorescent fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs and canopy lights.

HVAC

Heating: The units are heated by individual electric resistance heaters.

Cooling: DX cooling provided by the heat pumps. There are a variety of condensing units.

DHW: Domestic hot water is provided by individual electric packaged hot water heaters ranging 30-40 gallons, depending on unit size. A variety of models are present.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

William Sinkin

Number of Units: 50
Construction Date: 1980
Senior Housing
Number of Stories: 1
Bedroom Distribution: 45 1-bedroom, 5 2-bedroom

Building Envelope

William Sinkin is a senior site comprised of one story duplexes. The units have double pane windows with aluminum frames, wood-framed walls with a brick exterior, and a sloped, shingled roof with 11" of blown-in fiberglass insulation

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at William Sinkin consist of wall and ceiling mounted fixtures in the bedrooms, bathrooms, hallways, living rooms, and kitchens. The fixtures contain predominantly incandescent bulbs, although some compact fluorescent (CFL) bulbs were present.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of wall packs and ceiling fixtures.

HVAC

Heating: The units are heated by individual natural gas furnaces (45 MBH input, 80% efficiency).

Cooling: Cooling is provided by window air conditioning units.

DHW: Domestic hot water (DHW) is provided by individual natural gas packaged hot water heaters (30-40 gallon capacity).

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

Williamsburg

Number of Units: 15
Construction Date: 1971
Senior Housing
Number of Stories: 2
Bedroom Distribution: 15 1-bedroom

Building Envelope

Williamsburg is a senior site comprised of a two story walk-up building. The units have single pane windows with aluminum frames, wood-framed walls with a brick façade, and a sloped, shingled roof with an assumed R value of 11.

Lighting

Interior Lighting Technology Type: The lighting in a typical unit at Williamsburg consists of ceiling fixtures in the bedrooms, living rooms, and bathrooms, with incandescent bulbs. The bathrooms also have a vanity fixture, and the hallways have a wall mounted fixture, all with incandescent bulbs. The kitchens each have a 4' T12 linear fluorescent fixture.

Exterior Lighting Technology Type: The common area lighting is a mix of screw-in bulbs and linear fluorescents. Exterior lighting consists of canopy fixtures, wall packs, and sign lights.

HVAC

Heating: The units are heated by individual natural gas (80% efficiency) furnaces, with a variety of models present. The furnaces are controlled by analog, non-programmable thermostats.

Cooling: Cooling is provided by window air conditioning units.

DHW: Domestic hot water (DHW) is provided by (2) natural gas Ruud packaged hot water heaters (125 MBH input, 75 gallon capacity; 199 MBH input, 100 gallon capacity). The heaters are served by a 1/12 HP recirculation pump.

Ventilation: Exhaust is provided by individually vented bath fans. Ventilation is provided by operable windows.

4 Summary of Measures Evaluated

A broad range of measures was investigated during the investment grade energy audit. These measures are summarized below, and detailed in Section 5.

	Low Flow Aerators and Showerheads	Low Flow Toilet Flush Valves	In-Unit Lighting	Common Area Lighting	Exterior Lighting	Low Wattage Heat Lamps	Exhaust Fans and Low Wattage Heat Lamps	Electric Furnace to Heat Pump	Double Pane Windows	New Roof with Solar	Central Plant
Blanco	■	■	■	■	■					■	■
Cheryl West	■	■	■	■	■	■					
Christ the King	■	■	■	■	■		■	■			
Col. Cisneros	■		■	■	■				■		
Cross Creek	■	■	■	■	■		■				
Escondida	■	■	■	■	■	■					
Frank Hornsby	■	■	■	■	■		■	■			
H.B. Gonzalez	■	■	■	■	■	■					
Highview Apts	■	■	■	■	■						
Jewett Circle	■	■	■	■	■	■					
L.C. Rutledge	■	■	■	■	■	■	■				
Lewis Chatham	■	■	■	■	■						
Lila Cockrell	■	■	■	■	■	■		■			
Linda Lou	■	■	■	■	■						
Madonna	■	■	■	■	■						
Matt Garcia	■	■	■	■	■						
Midway	■	■	■	■	■						
Mirasol	■	■	■	■	■						
Mission Park	■	■	■	■	■	■					
Morris C. Beldon	■	■	■	■	■						
Pin Oak I	■	■	■	■	■	■					
Pin Oak II	■	■	■	■	■						
Raymundo Rangel	■	■	■	■	■						
Riverside Apts	■	■	■	■	■						
Sahara Ramsey	■		■	■	■	■					
South San	■	■	■	■	■			■			
Spring View	■	■	■			■	■				
Sun Park Lane	■	■	■	■	■	■					
T. L. Shaley	■	■	■	■	■		■				
Tarry Towne	■	■	■	■	■						
Villa Veramendi	■	■	■	■	■						
Westway	■	■	■	■	■			■			
William Sinkin	■	■	■	■	■	■					
Williamsburg	■	■	■	■	■						

4.1 Equipment Age

The age of all major equipment proposed to be replaced was assessed and is summarized below.

Site Name	Equipment	Average Age	Expected Useful Life
Blanco	Roof	35 years	30 years
Blanco	Boiler Plant	15-17 years	20 Years
Col Cisneros	Windows	40+ years	30 years
Christ the King	Electric Furnace	14 - 22 years	15 years

Frank Hornsby	Electric Furnace	13 - 24 years	15 years
Lila Cockrell	Electric Furnace	13 - 19 years	15 years
South San	Electric Furnace	16 - 23 years	15 years
Westway	Electric Furnace	14 - 21 years	15 years

5 Energy and Water Conservation Measures

5.1 Water

5.1.1 Low Flow Fixture Installation – ECM 2-110, 2-120, & 2-130

Site Name	Project #	Count and Descriptions		
Villa Veramendi	TX06-6012.0	166	WF1	kitchen aerator replacements (1.5 gpm)
		166	WF2	bathroom aerator replacements (1.0 gpm)
		166	WF3	handheld showerhead replacements (1.5 gpm)
		166	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Sun Park Lane	TX06-6023.0	65	WF1	kitchen aerator replacements (1.5 gpm)
		65	WF2	bathroom aerator replacements (1.0 gpm)
		65	WF3	handheld showerhead replacements (1.5 gpm)
		65	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Frank Hornsby	TX06-6124.0	59	WF1	kitchen aerator replacements (1.5 gpm)
		59	WF2	bathroom aerator replacements (1.0 gpm)
		59	WF3	handheld showerhead replacements (1.5 gpm)
		59	WF4b	tanked toilet flush valve replacement (1.28 gpf)
Mission Park	TX06-6024.0	100	WF1	kitchen aerator replacements (1.5 gpm)
		116	WF2	bathroom aerator replacements (1.0 gpm)
		100	WF3	handheld showerhead replacements (1.5 gpm)
		116	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Tarry Towne	TX06-6026.1	98	WF1	kitchen aerator replacements (1.5 gpm)
		98	WF2	bathroom aerator replacements (1.0 gpm)
		98	WF3	handheld showerhead replacements (1.5 gpm)
		98	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Escondida	TX06-6033.1	20	WF1	kitchen aerator replacements (1.5 gpm)
		20	WF2	bathroom aerator replacements (1.0 gpm)
		20	WF3	handheld showerhead replacements (1.5 gpm)
		20	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Williamsburg	TX06-6033.3	15	WF1	kitchen aerator replacements (1.5 gpm)
		15	WF2	bathroom aerator replacements (1.0 gpm)
		15	WF3	handheld showerhead replacements (1.5 gpm)
		15	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Matt Garcia	TX06-6055.0	55	WF1	kitchen aerator replacements (1.5 gpm)
		55	WF2	bathroom aerator replacements (1.0 gpm)
		55	WF3	handheld showerhead replacements (1.5 gpm)
		55	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Blanco	TX06-6029.0	100	WF1	kitchen aerator replacements (1.5 gpm)

		100	WF2	bathroom aerator replacements (1.0 gpm)
		100	WF3	handheld showerhead replacements (1.5 gpm)
		100	WF4c	tankless toilet flush valve replacement (1.6 gpf)
Lewis Chatham	TX06-6030.0	119	WF1	kitchen aerator replacements (1.5 gpm)
		119	WF2	bathroom aerator replacements (1.0 gpm)
		119	WF3	handheld showerhead replacements (1.5 gpm)
		119	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Linda Lou	TX06-6026.3	10	WF1	kitchen aerator replacements (1.5 gpm)
		10	WF2	bathroom aerator replacements (1.0 gpm)
		10	WF3	handheld showerhead replacements (1.5 gpm)
		10	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Riverside Apts	TX06-6031.0	74	WF1	kitchen aerator replacements (1.5 gpm)
		74	WF2	bathroom aerator replacements (1.0 gpm)
		74	WF3	handheld showerhead replacements (1.5 gpm)
		74	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Midway	TX06-6040.0	20	WF1	kitchen aerator replacements (1.5 gpm)
		20	WF2	bathroom aerator replacements (1.0 gpm)
		20	WF3	handheld showerhead replacements (1.5 gpm)
		20	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Madonna	TX06-6032.1	60	WF1	kitchen aerator replacements (1.5 gpm)
		60	WF2	bathroom aerator replacements (1.0 gpm)
		60	WF3	handheld showerhead replacements (1.5 gpm)
		60	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Sahara Ramsey	TX06-6032.2	16	WF1	kitchen aerator replacements (1.5 gpm)
		16	WF2	bathroom aerator replacements (1.0 gpm)
		16	WF3	handheld showerhead replacements (1.5 gpm)
Cheryl West	TX06-6034.0	82	WF1	kitchen aerator replacements (1.5 gpm)
		88	WF2	bathroom aerator replacements (1.0 gpm)
		88	WF3	handheld showerhead replacements (1.5 gpm)
		88	WF4a	tanked toilet flush valve replacement (1.6 gpf)
T. L. Shaley	TX06-6057.0	66	WF1	kitchen aerator replacements (1.5 gpm)
		70	WF2	bathroom aerator replacements (1.0 gpm)
		70	WF3	handheld showerhead replacements (1.5 gpm)
		70	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Jewett Circle	TX06-6038.0	75	WF1	kitchen aerator replacements (1.5 gpm)
		75	WF2	bathroom aerator replacements (1.0 gpm)
		75	WF3	handheld showerhead replacements (1.5 gpm)
		75	WF4c	tankless toilet flush valve replacement (1.6 gpf)
Col. Cisneros	TX06-6054.0	55	WF1	kitchen aerator replacements (1.5 gpm)
		55	WF2	bathroom aerator replacements (1.0 gpm)

		55	WF3	handheld showerhead replacements (1.5 gpm)
Highview Apts	TX06-6043.0	68	WF1	kitchen aerator replacements (1.5 gpm)
		72	WF2	bathroom aerator replacements (1.0 gpm)
		72	WF3	handheld showerhead replacements (1.5 gpm)
		72	WF4a	tanked toilet flush valve replacement (1.6 gpf)
William Sinkin	TX06-6052.0	50	WF1	kitchen aerator replacements (1.5 gpm)
		50	WF2	bathroom aerator replacements (1.0 gpm)
		50	WF3	handheld showerhead replacements (1.5 gpm)
		50	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Cross Creek	TX06-6044.0	66	WF1	kitchen aerator replacements (1.5 gpm)
		66	WF2	bathroom aerator replacements (1.0 gpm)
		66	WF3	handheld showerhead replacements (1.5 gpm)
		66	WF4b	tanked toilet flush valve replacement (1.28 gpf)
Morris C. Beldon	TX06-6049.0	35	WF1	kitchen aerator replacements (1.5 gpm)
		35	WF2	bathroom aerator replacements (1.0 gpm)
		35	WF3	handheld showerhead replacements (1.5 gpm)
		35	WF4b	tanked toilet flush valve replacement (1.28 gpf)
L.C. Rutledge	TX06-6056.0	66	WF1	kitchen aerator replacements (1.5 gpm)
		66	WF2	bathroom aerator replacements (1.0 gpm)
		66	WF3	handheld showerhead replacements (1.5 gpm)
		66	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Westway	TX06-6047.0	152	WF1	kitchen aerator replacements (1.5 gpm)
		240	WF2	bathroom aerator replacements (1.0 gpm)
		240	WF3	handheld showerhead replacements (1.5 gpm)
		240	WF4a	tanked toilet flush valve replacement (1.6 gpf)
H.B. Gonzalez	TX06-6051.0	51	WF1	kitchen aerator replacements (1.5 gpm)
		51	WF2	bathroom aerator replacements (1.0 gpm)
		51	WF3	handheld showerhead replacements (1.5 gpm)
		51	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Pin Oak II	TX06-6053.0	22	WF1	kitchen aerator replacements (1.5 gpm)
		22	WF2	bathroom aerator replacements (1.0 gpm)
		22	WF3	handheld showerhead replacements (1.5 gpm)
		22	WF4b	tanked toilet flush valve replacement (1.28 gpf)
Lila Cockrell	TX06-6058.0	70	WF1	kitchen aerator replacements (1.5 gpm)
		70	WF2	bathroom aerator replacements (1.0 gpm)
		70	WF3	handheld showerhead replacements (1.5 gpm)
		70	WF4a	tanked toilet flush valve replacement (1.6 gpf)
South San	TX06-6130.0	30	WF1	kitchen aerator replacements (1.5 gpm)
		30	WF2	bathroom aerator replacements (1.0 gpm)

		30	WF3	handheld showerhead replacements (1.5 gpm)
		30	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Raymundo Rangel	TX06-6129.0	26	WF1	kitchen aerator replacements (1.5 gpm)
		26	WF2	bathroom aerator replacements (1.0 gpm)
		26	WF3	handheld showerhead replacements (1.5 gpm)
		26	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Mirasol	TX06-6135.0 TX06-6137.0 TX06-6138.0	174	WF1	kitchen aerator replacements (1.5 gpm)
		304	WF2	bathroom aerator replacements (1.0 gpm)
		304	WF3	handheld showerhead replacements (1.5 gpm)
		304	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Christ the King	TX06-6143.0	48	WF1	kitchen aerator replacements (1.5 gpm)
		48	WF2	bathroom aerator replacements (1.0 gpm)
		48	WF3	handheld showerhead replacements (1.5 gpm)
		48	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Spring View	TX06-6125.0 TX06-6136.0 TX06-6140.0	161	WF1	kitchen aerator replacements (1.5 gpm)
		282	WF2	bathroom aerator replacements (1.0 gpm)
		282	WF3	handheld showerhead replacements (1.5 gpm)
		282	WF4a	tanked toilet flush valve replacement (1.6 gpf)
Pin Oak I	TX06-6054.1	50	WF1	kitchen aerator replacements (1.5 gpm)
		50	WF2	bathroom aerator replacements (1.0 gpm)
		50	WF3	handheld showerhead replacements (1.5 gpm)
		50	WF4a	tanked toilet flush valve replacement (1.6 gpf)
TOTAL		**2,324**	**WF1**	**kitchen aerator replacements (1.5 gpm)**
		2,693	**WF2**	**bathroom aerator replacements (1.0 gpm)**
		2,677	**WF3**	**handheld showerhead replacements (1.5 gpm)**
		2,265	**WF4a**	**tanked toilet flush valve replacement (1.6 gpf)**
		182	**WF4b**	**tanked toilet flush valve replacement (1.28 gpf)**
		175	**WF4c**	**tankless toilet flush valve replacement (1.6 gpf)**

There are a number of in-unit water fixtures that are conventional flow. The efficiency measure is to replace all bathroom aerators with 1.0 gpm aerators, all kitchen aerators with 1.5 gpm aerators, all showerheads with 1.5 gpm handheld showerheads, and all toilets with 1.6 gpf or 1.28 gpf flush valves as listed above. The installing contractor should verify the exact number of each fixture to be remediated – please see pricing notes below on how to price.

Group14 recommends that all existing water fixtures be replaced as part of this effort – low flow and conventional flow. Due to the low material cost of these fixtures, doing a 100% replacement will ensure a longer useful life and saving persistence of the measure, and reduce the labor associated with investigating existing flow rates to justify each retrofit.

The following specifications apply.

- 013300 – SUBMITTAL PROCEDURES
- 014000 – QUALITY REQUIREMENTS
- 017823 – OPERATION AND MAINTENANCE DATA

- 017839 – PROJECT RECORD DOCUMENTS
- 017900 – DEMONSTRATION AND TRAINING
- 019113 – GENERAL COMMISSIONING REQUIREMENTS
- 224200 – PLUMBING FIXTURES

Improvements to Operations and Maintenance:

The new low flow water fixtures should reduce the number of existing leaks and associated work orders.

Pricing and Site-Specific Installation Notes to Contractor:

Please price out at a 100% installation rate for these items, represented by the fixture count in the table at the beginning of this section. Please provide an allowance for new shutoff valves and supply hoses at 15% of units.

There may be dual flush toilets in some units for which the specified flush valve replacement is not appropriate. Please skip over these toilets and offer a deduct. These are not anticipated to be a problem at more than 3-4 sites, at fewer than half of units at those sites.

Please ensure that the toilet valve replacements include both the fill valve and the flapper.

Also provide a per unit materials and labor price based on the specified basis of design products available through HD Supply, or the Authority's current procurement partner if different. Model numbers are listed in the spec. If the installed count varies from the count in the table above, it is anticipated that a deduct or add will be offered using this per unit price. **It is the contractor's responsibility to ensure that the aerator finish matches the existing faucet finish.** During installation, the contractor will be responsible for noting any obvious leaks at the water fixture. These should be tracked by unit and reported to the Housing Authority. After installation, please leave a limited supply of the plumbing fixtures including aerators, flush valves, and showerheads, for the maintenance staff at each property. Additionally, to reduce impact on residents, the contractor must be appropriately staffed to allow the installation crew to install ECMs at an efficient pace.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									Total Energy Savings
		Water & Sewer			Electricity			Natural Gas			
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Villa Veramendi	Aerators -Kitchen/Bath AP	1,182,888	$ 0.0093	$ 11,001	128,317	$ 0.1147	$ 14,722	-	-	-	$ 25,723
Villa Veramendi	LF Showerheads-AP	849,818	$ 0.0093	$ 7,903	30,764	$ 0.1147	$ 3,530	-	-	-	$ 11,433
Villa Veramendi	LF Toilet Flush Valves AP	427,126	$ 0.0093	$ 3,972	-	-	-	-	-	-	$ 3,972
Sun Park Lane	Aerators -Kitchen/Bath AP	57,717	$ 0.0096	$ 554	-	-	-	263	$ 0.6097	$ 160	$ 714
Sun Park Lane	LF Showerheads-AP	106,555	$ 0.0096	$ 1,023	-	-	-	1,213	$ 0.6097	$ 740	$ 1,763
Sun Park Lane	LF Toilet Flush Valves AP	34,511	$ 0.0096	$ 331	-	-	-	-	-	-	$ 331
Frank Hornsby	Aerators -Kitchen/Bath AP	79,961	$ 0.0096	$ 768	7,686	$ 0.1147	$ 882	-	-	-	$ 1,649
Frank Hornsby	LF Showerheads-AP	95,452	$ 0.0096	$ 916	4,306	$ 0.1147	$ 494	-	-	-	$ 1,410
Frank Hornsby	LF Toilet Flush Valves AP	4,057	$ 0.0096	$ 39	-	-	-	-	-	-	$ 39
Mission Park	Aerators -Kitchen/Bath AP	764,754	$ 0.0080	$ 6,118	46,584	$ 0.1147	$ 5,344	-	-	-	$ 11,462
Mission Park	LF Showerheads-AP	617,390	$ 0.0080	$ 4,939	13,663	$ 0.1147	$ 1,567	-	-	-	$ 6,507
Mission Park	LF Toilet Flush Valves AP	269,388	$ 0.0080	$ 2,155	-	-	-	-	-	-	$ 2,155
Tarry Towne	Aerators -Kitchen/Bath AP	170,977	$ 0.0100	$ 1,710	-	-	-	669	$ 0.6292	$ 421	$ 2,131
Tarry Towne	LF Showerheads-AP	98,714	$ 0.0100	$ 987	-	-	-	751	$ 0.6292	$ 473	$ 1,460
Tarry Towne	LF Toilet Flush Valves AP	117,469	$ 0.0100	$ 1,175	-	-	-	-	-	-	$ 1,175
Escondida	Aerators -Kitchen/Bath AP	37,189	$ 0.0100	$ 372	-	-	-	259	$ 0.6292	$ 163	$ 535
Escondida	LF Showerheads-AP	31,938	$ 0.0100	$ 319	-	-	-	421	$ 0.6292	$ 265	$ 585
Escondida	LF Toilet Flush Valves AP	1,253	$ 0.0100	$ 13	-	-	-	-	-	-	$ 13
Williamsburg	Aerators -Kitchen/Bath AP	36,464	$ 0.0100	$ 365	-	-	-	204	$ 0.6292	$ 128	$ 493
Williamsburg	LF Showerheads-AP	52,058	$ 0.0100	$ 521	-	-	-	538	$ 0.6292	$ 338	$ 859
Williamsburg	LF Toilet Flush Valves AP	22,125	$ 0.0100	$ 221	-	-	-	-	-	-	$ 221
Matt Garcia	Aerators -Kitchen/Bath AP	31,827	$ 0.0106	$ 337	10,035	$ 0.1126	$ 1,130	-	-	-	$ 1,467
Matt Garcia	LF Showerheads-AP	6,860	$ 0.0106	$ 73	596	$ 0.1126	$ 67	-	-	-	$ 140
Matt Garcia	LF Toilet Flush Valves AP	13,684	$ 0.0106	$ 145	-	-	-	-	-	-	$ 145
Blanco	Aerators -Kitchen/Bath AP	249,469	$ 0.0100	$ 2,495	-	-	-	863	$ 0.7871	$ 679	$ 3,174
Blanco	LF Showerheads-AP	103,872	$ 0.0100	$ 1,039	-	-	-	649	$ 0.7871	$ 511	$ 1,550
Blanco	LF Toilet Flush Valves AP	97,120	$ 0.0100	$ 971	-	-	-	-	-	-	$ 971
Lewis Chatham	Aerators -Kitchen/Bath AP	163,782	$ 0.0092	$ 1,507	-	-	-	370	$ 0.6157	$ 228	$ 1,735
Lewis Chatham	LF Showerheads-AP	183,215	$ 0.0092	$ 1,686	-	-	-	705	$ 0.6157	$ 434	$ 2,120
Lewis Chatham	LF Toilet Flush Valves AP	77,866	$ 0.0092	$ 716	-	-	-	-	-	-	$ 716
Linda Lou	Aerators -Kitchen/Bath AP	4,332	$ 0.0087	$ 38	-	-	-	1	$ 0.8211	$ 1	$ 39
Linda Lou	LF Showerheads-AP	10,396	$ 0.0087	$ 90	-	-	-	8	$ 0.8211	$ 7	$ 97
Linda Lou	LF Toilet Flush Valves AP	4,418	$ 0.0087	$ 38	-	-	-	-	-	-	$ 38

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									Total Energy Savings
		Water & Sewer			Electricity			Natural Gas			
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Riverside Apts	Aerators -Kitchen/Bath AP	456,715	$ 0.0087	$ 3,973	-	-	-	1,720	$ 0.9268	$ 1,594	$ 5,567
Riverside Apts	LF Showerheads-AP	263,683	$ 0.0087	$ 2,294	-	-	-	284	$ 0.9268	$ 264	$ 2,558
Riverside Apts	LF Toilet Flush Valves AP	199,993	$ 0.0087	$ 1,740	-	-	-	-	-	-	$ 1,740
Linda Lou	Aerators -Kitchen/Bath AP	6,497	$ 0.0087	$ 57	-	-	-	2	$ 0.8211	$ 2	$ 58
Linda Lou	LF Showerheads-AP	15,594	$ 0.0087	$ 136	-	-	-	12	$ 0.8211	$ 10	$ 146
Linda Lou	LF Toilet Flush Valves AP	6,628	$ 0.0087	$ 58	-	-	-	-	-	-	$ 58
Midway	Aerators -Kitchen/Bath AP	46,986	$ 0.0087	$ 409	-	-	-	90	$ 0.8211	$ 74	$ 483
Midway	LF Showerheads-AP	68,913	$ 0.0087	$ 600	-	-	-	331	$ 0.8211	$ 272	$ 871
Midway	LF Toilet Flush Valves AP	29,288	$ 0.0087	$ 255	-	-	-	-	-	-	$ 255
Madonna	Aerators -Kitchen/Bath AP	121,517	$ 0.0096	$ 1,167	-	-	-	631	$ 0.6569	$ 415	$ 1,581
Madonna	LF Showerheads-AP	131,069	$ 0.0096	$ 1,258	-	-	-	1,213	$ 0.6569	$ 797	$ 2,055
Madonna	LF Toilet Flush Valves AP	66,845	$ 0.0096	$ 642	-	-	-	-	-	-	$ 642
Sahara Ramsey	Aerators -Kitchen/Bath AP	35,552	$ 0.0096	$ 341	-	-	-	117	$ 0.6569	$ 77	$ 418
Sahara Ramsey	LF Showerheads-AP	52,143	$ 0.0096	$ 501	-	-	-	430	$ 0.6569	$ 282	$ 783
Cheryl West	Aerators -Kitchen/Bath AP	276,930	$ 0.0086	$ 2,382	-	-	-	842	$ 0.9124	$ 768	$ 3,150
Cheryl West	LF Showerheads-AP	345,510	$ 0.0086	$ 2,971	-	-	-	367	$ 0.9124	$ 334	$ 3,306
Cheryl West	LF Toilet Flush Valves AP	216,067	$ 0.0086	$ 1,858	-	-	-	-	-	-	$ 1,858
T. L. Shaley	Aerators -Kitchen/Bath AP	1,253,476	$ 0.0100	$ 12,509	-	-	-	842	$ 0.9238	$ 778	$ 13,287
T. L. Shaley	LF Showerheads-AP	419,201	$ 0.0100	$ 4,184	-	-	-	367	$ 0.9238	$ 339	$ 4,522
T. L. Shaley	LF Toilet Flush Valves AP	140,307	$ 0.0100	$ 1,400	-	-	-	-	-	-	$ 1,400
Jewett Circle	Aerators -Kitchen/Bath AP	110,855	$ 0.0100	$ 1,109	-	-	-	168	$ 0.6208	$ 105	$ 1,213
Jewett Circle	LF Showerheads-AP	150,046	$ 0.0100	$ 1,500	-	-	-	570	$ 0.6208	$ 354	$ 1,854
Jewett Circle	LF Toilet Flush Valves AP	93,529	$ 0.0100	$ 935	-	-	-	-	-	-	$ 935
Col. Cisneros	Aerators -Kitchen/Bath AP	78,014	$ 0.0100	$ 780	9,275	$ 0.1151	$ 1,067	-	-	-	$ 1,848
Col. Cisneros	LF Showerheads-AP	98,544	$ 0.0100	985	6,069	$ 0.1151	$ 698	-	-	-	$ 1,684
Highview Apts	Aerators -Kitchen/Bath AP	306,345	$ 0.0084	$ 2,573	-	-	-	408	$ 1.7127	$ 699	$ 3,272
Highview Apts	LF Showerheads-AP	445,593	$ 0.0084	$ 3,743	-	-	-	1,484	$ 1.7127	$ 2,541	$ 6,284
Highview Apts	LF Toilet Flush Valves AP	246,190	$ 0.0084	$ 2,068	-	-	-	-	-	-	$ 2,068
William Sinkin	Aerators -Kitchen/Bath AP	71,328	$ 0.0084	$ 599	-	-	-	250	$ 1.3659	$ 341	$ 941
William Sinkin	LF Showerheads-AP	57,993	$ 0.0084	$ 487	-	-	-	76	$ 1.3659	$ 104	$ 592
William Sinkin	LF Toilet Flush Valves AP	23,239	$ 0.0084	$ 195	-	-	-	-	-	-	$ 195
Cross Creek	Aerators -Kitchen/Bath AP	373,501	$ 0.0087	$ 3,249	-	-	-	1,158	$ 0.9098	$ 1,053	$ 4,303
Cross Creek	LF Showerheads-AP	397,284	$ 0.0087	$ 3,456	-	-	-	577	$ 0.9098	$ 525	$ 3,982
Cross Creek	LF Toilet Flush Valves AP	12,988	$ 0.0087	$ 113	-	-	-	-	-	-	$ 113
Morris C. Beldon	Aerators -Kitchen/Bath AP	172,515	$ 0.0087	$ 1,501	11,270	$ 0.1147	$ 1,293	53	$ 1.1446	$ 60	$ 2,854
Morris C. Beldon	LF Showerheads-AP	179,336	$ 0.0087	$ 1,560	5,492	$ 0.1147	$ 630	26	$ 1.1446	$ 29	$ 2,220
Morris C. Beldon	LF Toilet Flush Valves AP	5,863	$ 0.0087	$ 51	-	-	-	-	-	-	$ 51
L.C. Rutledge	Aerators -Kitchen/Bath AP	243,927	$ 0.0087	$ 2,122	-	-	-	1,059	$ 0.9585	$ 1,015	$ 3,137
L.C. Rutledge	LF Showerheads-AP	454,683	$ 0.0087	$ 3,956	-	-	-	541	$ 0.9585	$ 518	$ 4,474
L.C. Rutledge	LF Toilet Flush Valves AP	193,529	$ 0.0087	$ 1,684	-	-	-	-	-	-	$ 1,684
Westway	Aerators -Kitchen/Bath AP	724,570	$ 0.0084	$ 6,086	67,257	$ 0.1145	$ 7,699	-	-	-	$ 13,786
Westway	LF Showerheads-AP	294,447	$ 0.0084	$ 2,473	6,545	$ 0.1145	$ 749	-	-	-	$ 3,223
Westway	LF Toilet Flush Valves AP	209,742	$ 0.0084	$ 1,762	-	-	-	-	-	-	$ 1,762
H.B. Gonzalez	Aerators -Kitchen/Bath AP	74,982	$ 0.0084	$ 630	-	-	-	172	$ 0.6136	$ 105	$ 735
H.B. Gonzalez	LF Showerheads-AP	69,361	$ 0.0084	$ 583	-	-	-	311	$ 0.6136	$ 191	$ 773
H.B. Gonzalez	LF Toilet Flush Valves AP	35,374	$ 0.0084	$ 297	-	-	-	-	-	-	$ 297
Pin Oak II	Aerators -Kitchen/Bath AP	70,970	$ 0.0090	$ 639	-	-	-	188	$ 0.9761	$ 183	$ 822
Pin Oak II	LF Showerheads-AP	134,197	$ 0.0090	$ 1,208	-	-	-	166	$ 0.9761	$ 162	$ 1,369
Pin Oak II	LF Toilet Flush Valves AP	4,387	$ 0.0090	$ 39	-	-	-	-	-	-	$ 39
Lila Cockrell	Aerators -Kitchen/Bath AP	127,987	$ 0.0094	$ 1,203	-	-	-	241	$ 0.6012	$ 145	$ 1,348
Lila Cockrell	LF Showerheads-AP	24,497	$ 0.0094	$ 230	-	-	-	95	$ 0.6012	$ 57	$ 287
Lila Cockrell	LF Toilet Flush Valves AP	28,557	$ 0.0094	$ 268	-	-	-	-	-	-	$ 268
South San	Aerators -Kitchen/Bath AP	150,197	$ 0.0094	$ 1,412	8,001	$ 0.1143	$ 915	-	-	-	$ 2,327
South San	LF Showerheads-AP	72,878	$ 0.0094	$ 685	1,040	$ 0.1143	$ 119	-	-	-	$ 804
South San	LF Toilet Flush Valves AP	68,141	$ 0.0094	$ 641	-	-	-	-	-	-	$ 641
Raymundo Rangel	Aerators -Kitchen/Bath AP	156,272	$ 0.0097	$ 1,516	5,871	$ 0.1142	$ 671	-	-	-	$ 2,186
Raymundo Rangel	LF Showerheads-AP	62,433	$ 0.0097	$ 606	685	$ 0.1142	$ 78	-	-	-	$ 684
Raymundo Rangel	LF Toilet Flush Valves AP	74,295	$ 0.0097	$ 721	-	-	-	-	-	-	$ 721
Mirasol Homes	Aerators -Kitchen/Bath AP	162,410	$ 0.0097	$ 1,575	22,873	$ 0.1153	$ 2,637	-	-	-	$ 4,212
Mirasol Homes	Aerators -Kitchen/Bath RP	1,462,984	$ 0.0099	$ 14,417	61,840	$ 0.1153	$ 7,129	-	-	-	$ 21,546
Mirasol Homes	LF Showerheads-AP	101,506	$ 0.0097	$ 985	4,398	$ 0.1153	$ 507	-	-	-	$ 1,492
Mirasol Homes	LF Showerheads-RP	319,087	$ 0.0099	$ 3,144	11,891	$ 0.1153	$ 1,371	-	-	-	$ 4,515
Mirasol Homes	LF Toilet Flush Valves AP	69,025	$ 0.0097	$ 670	-	-	-	-	-	-	$ 670
Mirasol Homes	LF Toilet Flush Valves RP	196,509	$ 0.0099	$ 1,936	-	-	-	-	-	-	$ 1,936
Mirasol Townhomes	Aerators -Kitchen/Bath AP	118,117	$ 0.0097	$ 1,146	12,337	$ 0.1150	$ 1,418	-	-	-	$ 2,564
Mirasol Townhomes	LF Showerheads-AP	73,823	$ 0.0097	$ 716	2,372	$ 0.1150	$ 273	-	-	-	$ 989
Mirasol Townhomes	LF Toilet Flush Valves AP	50,200	$ 0.0097	$ 487	-	-	-	-	-	-	$ 487
Mirasol Cottages	Aerators -Kitchen/Bath AP	98,431	$ 0.0097	$ 955	8,225	$ 0.1145	$ 942	-	-	-	$ 1,897
Mirasol Cottages	LF Showerheads-AP	41,833	$ 0.0097	$ 406	1,581	$ 0.1145	$ 181	-	-	-	$ 587
Mirasol Cottages	LF Toilet Flush Valves AP	62,750	$ 0.0097	$ 609	-	-	-	-	-	-	$ 609
Christ the King	Aerators -Kitchen/Bath AP	131,840	$ 0.0097	$ 1,279	17,319	$ 0.1152	$ 1,995	-	-	-	$ 3,273
Christ the King	LF Showerheads-AP	17,058	$ 0.0097	$ 165	522	$ 0.1152	$ 60	-	-	-	$ 226
Christ the King	LF Toilet Flush Valves AP	46,397	$ 0.0097	$ 450	-	-	-	-	-	-	$ 450

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									
		Water & Sewer			Electricity			Natural Gas			Total Energy Savings
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Riverside Apts	Aerators -Kitchen/Bath AP	456,715	$ 0.0087	$ 3,973	-	-	-	1,720	$ 0.9268	$ 1,594	$ 5,567
Riverside Apts	LF Showerheads-AP	263,683	$ 0.0087	$ 2,294	-	-	-	284	$ 0.9268	$ 264	$ 2,558
Riverside Apts	LF Toilet Flush Valves AP	199,993	$ 0.0087	$ 1,740	-	-	-	-	-	-	$ 1,740
Linda Lou	Aerators -Kitchen/Bath AP	6,497	$ 0.0087	$ 57	-	-	-	2	$ 0.8211	$ 2	$ 58
Linda Lou	LF Showerheads-AP	15,594	$ 0.0087	$ 136	-	-	-	12	$ 0.8211	$ 10	$ 146
Spring View Scat.	Aerators -Kitchen/Bath AP	65,651	$ 0.0091	$ 597	7,612	$ 0.1149	$ 875	-	-	-	$ 1,472
Spring View Scat.	LF Showerheads-AP	54,438	$ 0.0091	$ 495	2,244	$ 0.1149	$ 258	-	-	-	$ 753
Spring View Scat.	LF Toilet Flush Valves AP	24,398	$ 0.0091	$ 222	-	-	-	-	-	-	$ 222
Spring View	Aerators -Kitchen/Bath AP	728,731	$ 0.0091	$ 6,631	59,522	$ 0.1144	$ 6,809	-	-	-	$ 13,440
Spring View	LF Showerheads-AP	604,257	$ 0.0091	$ 5,499	17,551	$ 0.1144	$ 2,008	-	-	-	$ 7,506
Spring View	LF Toilet Flush Valves AP	270,817	$ 0.0091	$ 2,464	-	-	-	-	-	-	$ 2,464
Spring View Sr.	Aerators -Kitchen/Bath AP	262,606	$ 0.0091	$ 2,390	12,178	$ 0.1183	$ 1,441	-	-	-	$ 3,830
Spring View Sr.	LF Showerheads-AP	217,750	$ 0.0091	$ 1,982	3,591	$ 0.1183	$ 425	-	-	-	$ 2,406
Spring View Sr.	LF Toilet Flush Valves AP	97,592	$ 0.0091	$ 888	-	-	-	-	-	-	$ 888
Pin Oak I	Aerators -Kitchen/Bath AP	70,970	$ 0.0087	$ 617	-	-	-	122	$ 0.5903	$ 72	$ 689
Pin Oak I	LF Showerheads-AP	134,197	$ 0.0087	$ 1,168	-	-	-	1,056	$ 0.5903	$ 624	$ 1,791
Pin Oak I	LF Toilet Flush Valves AP	4,387	$ 0.0087	$ 38	-	-	-	-	-	-	$ 38

Calculation Methodology:

The total water use for each site was taken from historical utility data. The following breakdown in usage was assumed:

	Percent of Total Water Usage
Kitchen Faucets	12%
Lavatory Faucets	10%
Showers	20%
Toilets	17%
Laundry	10%
Misc.	31%

$$Wt\ Sav = Ann\ Wat \times \%\ Use \times \left(1 - \frac{Avg\ GPM_{new}}{Avg\ GPM_{old}}\right)$$

Wt Sav – Total Water Savings, gal/year

Ann Wat – Annual non-irrigation building water use, gal/year

% Use – Percentage of total water load based on the above table = 0.12 (12%) for kitchen faucets, 0.1 (10%) for the bathroom lavatory faucets, 0.2 (20%) for showerheads

Avg GPM_{new} – Flowrate of low-flow fixtures, gpm = 1.5 kitchen, 0.5 bathroom, 1.5 showerhead

Avg GPM_{old} – Average flowrate of existing fixtures, gpm *based on the energy audit*

For the authority paid gas sites, the gas savings is calculated in a similar manner. The total baseload natural gas use for each site was taken from historical utility data. The following breakdown in usage was assumed:

	Percent of Total Hot Water Use
Kitchen Faucets	16%
Lavatory Faucets	7%
Showers	34%
Toilets	0%
Laundry	17%
Misc.	26%

$$Gas/Ele\ Sav = Ann\ DHW \times \%\ Use \times \left(1 - \frac{Avg\ GPM_{new}}{Avg\ GPM_{old}}\right)$$

Gas/Ele Sav – Total Electric or Natural Gas Saving, ccf or kWh/year

Ann DHW – Annual gas/electric use for DHW, ccf /year

% Use – Percentage of total water load based on the above table = 0.16 (16%) for kitchen faucets, 0.7 (7%) for the bathroom lavatory faucets, 0.34 (34%) for showerheads

Avg GPM_{new} – Flowrate of low-flow fixtures, gpm = 1.5 kitchen, 0.5 bathroom, 1.5 showerhead

Avg GPM_{old} – Average flowrate of existing fixtures, gpm *based on the energy audit*

For the resident paid gas sites, the gas savings was calculated based on the assumption that 20% of water used for aerators, showerheads, and toilets is hot water used in aerators and showerheads. Aerators make up 75% of that hot water use, and showerheads make up 25% of that hot water use.

All savings calculation details can be found on the "Low Flow" tab within the "SAHA Phase II Savings Calculator" excel spreadsheet included with this report.

5.2 Lighting

The following performance-based specification sections are related to all scopes of work included in this section (note: some information in the specifications may relate to other scopes of work and may not be germane to this scope of work). The Lighting specification section includes detailed notes on fixture and control technology types, as well as basis of design products.

- 013300 – SUBMITTAL PROCEDURES
- 014000 – QUALITY REQUIREMENTS
- 017823 – OPERATION AND MAINTENANCE DATA
- 017839 – PROJECT RECORD DOCUMENTS
- 017900 – DEMONSTRATION AND TRAINING
- 019113 – GENERAL COMMISSIONING REQUIREMENTS
- 233450 – BATHROOM EXHAUST FANS
- 260500 – ELECTRICAL POWER AND LIGHTING SYSTEMS

5.2.1 In-Unit Lighting Retrofit – ECM 2-210

Site Name	Project #	Count and Descriptions		
Villa Veramendi		2,324	L1	LEDs provided for hard-wired lamps (9.5W)

	TX06-6012.0	498	L5a	8.5W LED 2 pin bulbs provided for hardwired fixtures
		830	L5b	8.5W LED 4 pin bulbs provided for hardwired fixtures
		332	RL6 (4')	Re-lamp 2-bulb 4' T8 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Sun Park Lane	TX06-6023.0	715	L1	LEDs provided for hard-wired lamps (9.5W)
Frank Hornsby	TX06-6124.0	590	L1	LEDs provided for hard-wired lamps (9.5W)
		118	RL6 (4')	Re-lamp 2-bulb 4' T8/T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Mission Park	TX06-6024.0	2,200	L1	LEDs provided for hard-wired lamps (9.5W)
		200	RL6 (4')	Re-lamp 2-bulb 4' T8/T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		200	L5a	Re-lamp porch fixtures with 8.5W LED 2 pin bulbs provided for hardwired fixtures
Tarry Towne	TX06-6026.1	1,078	L1	LEDs provided for hard-wired lamps (9.5W)
		196	RL6 (4')	Re-lamp 2-bulb 4' T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		98	RL6 (4')	Re-lamp 1-bulb 4' T12 vanity fixture with 4' Type C LED Tubes with Remote Driver
Escondida	TX06-6033.1	140	L1	LEDs provided for hard-wired lamps (9.5W)
		40	RL6 (4')	Re-lamp 2-bulb 4' T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		20	RL5 (3')	Re-lamp 1-bulb 3' T12 vanity with 3' Type C LED Tubes with Remote Driver
		20	L6	Candelabra LEDs provided for hard-wired fixtures (7W)
Williamsburg	TX06-6033.3	150	L1	LEDs provided for hard-wired lamps (9.5W)
		30	RL6 (4')	Re-lamp 2-bulb 4' T8 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Matt Garcia	TX06-6055.0	605	L1	LEDs provided for hard-wired lamps (9.5W)
		110	RL6 (4')	Re-lamp 2-bulb 4' T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Blanco	TX06-6029.0	700	L1	LEDs provided for hard-wired lamps (9.5W)
		200	RL6 (4')	Re-lamp 2-bulb 4' T8 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Lewis Chatham	TX06-6030.0	119	L1	LEDs provided for hard-wired lamps (9.5W)
		1,071	L1d	9W GU24 base LEDs provided for hardwired fixtures
		238	L5a	8.5W LED 2 pin bulbs provided for hardwired fixtures
		238	RL4 (2')	Re-lamp 2-bulb 2' T8 vanity fixture with 2' Type C LED Tubes with Remote Driver
		119	RS1	8W LED under cabinet fixtures
Linda Lou	TX06-6026.3	50	L1	LEDs provided for hard-wired lamps (9.5W)
		20	RL6 (4')	Re-lamp 4-bulb 4' T8/12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		20	RL4 (2')	Re-lamp 2-bulb 2' T8 vanity fixture with 2' Type C LED Tubes with Remote Driver

		18	WP5	9W LED wall sconces
Riverside Apts	TX06-6031.0	1,554	L1	LEDs provided for hard-wired lamps (9.5W)
		148	RL6 (4')	Re-lamp 2-bulb 4' T8/T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Midway	TX06-6040.0	260	L1	LEDs provided for hard-wired lamps (9.5W)
		14	RL6 (4')	Re-lamp 2-bulb 4' T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		20	WP5	9W LED wall sconces
Madonna	TX06-6032.1	1,020	L1	LEDs provided for hard-wired lamps (9.5W)
		20	L6	Candelabra LEDs provided for hard-wired fixtures (7W)
		60	WP5	9W LED wall sconces
Sahara Ramsey	TX06-6032.2	304	L1	LEDs provided for hard-wired lamps (9.5W)
Cheryl West	TX06-6034.0	902	L1	LEDs provided for hard-wired lamps (9.5W)
		164	RL4 (2')	Re-lamp 2-bulb 2' T8 kitchen fixture with 2' Type C LED Tubes with Remote Driver
T. L. Shaley	TX06-6057.0	792	L1	LEDs provided for hard-wired lamps (9.5W)
		132	RL4 (2')	Re-lamp 2-bulb 2' T12 kitchen fixture with 2' Type C LED Tubes with Remote Driver
		132	WP5	9W LED wall sconces
Jewett Circle	TX06-6038.0	900	L1	LEDs provided for hard-wired lamps (9.5W)
		150	RL6 (4')	Re-lamp 2-bulb 4' T8/T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Col. Cisneros	TX06-6054.0	550	L1	LEDs provided for hard-wired lamps (9.5W)
		110	RL6 (4')	Re-lamp 2-bulb 4' T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		110	WP5	9W LED wall sconces
Highview Apts	TX06-6043.0	1,088	L1	LEDs provided for hard-wired lamps (9.5W)
		68	WP5	9W LED wall sconces
William Sinkin	TX06-6052.0	750	L1	LEDs provided for hard-wired lamps (9.5W)
Cross Creek	TX06-6044.0	1,122	L1	LEDs provided for hard-wired lamps (9.5W)
		66	RL4 (2')	Re-lamp 2-bulb 2' T12 kitchen fixture with 2' Type C LED Tubes with Remote Driver
		66	RL6 (4')	Re-lamp 2-bulb 4' T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		132	LC3	11W LED porch ceiling fixture
Morris C. Beldon	TX06-6049.0	490	L1	LEDs provided for hard-wired lamps (9.5W)
		70	RL6 (4')	Re-lamp 2-bulb 4' T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		70	WP5	9W LED wall sconces
L.C. Rutledge		660	L1	LEDs provided for hard-wired lamps (9.5W)

	TX06-6056.0	132	RL6 (4')	Re-lamp 2-bulb 4' T8 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Westway	TX06-6047.0	2,432	L1	LEDs provided for hard-wired lamps (9.5W)
		304	RL6 (4')	Re-lamp 2-bulb 4' T8 kitchen fixture with 4' Type C LED Tubes with Remote Driver
H.B. Gonzalez	TX06-6051.0	612	L1	LEDs provided for hard-wired lamps (9.5W)
		102	RL4 (2')	Re-lamp 2-bulb 2' T8 kitchen fixture with 2' Type C LED Tubes with Remote Driver
		102	RL6 (4')	Re-lamp 2-bulb 4' T8 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Pin Oak II	TX06-6053.0	330	L1	LEDs provided for hard-wired lamps (9.5W)
		34	RL4 (2')	Re-lamp 2-bulb 2' T12 kitchen fixture with 2' Type C LED Tubes with Remote Driver
		34	RL6 (4')	Re-lamp 2-bulb 4' T8 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Lila Cockrell	TX06-6058.0	980	L1	LEDs provided for hard-wired lamps (9.5W)
		70	RL4 (2')	Re-lamp 2-bulb 2' T12 kitchen fixture with 2' Type C LED Tubes with Remote Driver
South San	TX06-6130.0	360	L1	LEDs provided for hard-wired lamps (9.5W)
		60	RL6 (4')	Re-lamp 2-bulb 4' T8 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		30	RL4 (2')	Re-lamp 1-bulb 2' T12 closet fixture with 2' Type C LED Tubes with Remote Driver
		30	WP5	9W LED wall sconces
Raymundo Rangel	TX06-6129.0	156	L1	LEDs provided for hard-wired lamps (9.5W)
		52	RL6 (4')	Re-lamp 2-bulb 4' T8/T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
Mirasol	TX06-6135.0 TX06-6137.0 TX06-6138.0	3,536	L1	LEDs provided for hard-wired lamps (9.5W)
		696	RL6 (4')	Re-lamp 4-bulb 4' T8/12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		40	RL4 (2')	Re-lamp 2-bulb 2' T8 vanity fixture with 2' Type C LED Tubes with Remote Driver
		44	L5a	8.5W LED 2 pin bulbs provided for hardwired fixtures
Christ the King	TX06-6143.0	432	L1	LEDs provided for hard-wired lamps (9.5W)
		48	RL6 (4')	Re-lamp 1-bulb 4' T8/T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		48	RL4 (2')	Re-lamp 1-bulb 2' T8 bathroom fixture with 2' Type C LED Tubes with Remote Driver
Spring View Spring View	TX06-6125.0 TX06-6136.0 TX06-6140.0	3,202	L1	LEDs provided for hard-wired lamps (9.5W)
		110	L5a	8.5W LED 2 pin bulbs provided for hardwired fixtures
		544	RL6 (4')	Re-lamp 2-bulb 4' T8/12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
		10	RL4 (2')	Re-lamp 1-bulb 2' T12 laundry fixture with 2' Type C LED Tubes with Remote Driver
		171	WP5	9W LED wall sconces
Pin Oak I		500	L1	LEDs provided for hard-wired lamps (9.5W)

	TX06-6054.1	30	RL6 (4')	Re-lamp 2-bulb 4' T12 kitchen fixture with 4' Type C LED Tubes with Remote Driver
TOTAL	**31,593**	**L1**	**LEDs provided for hard-wired lamps (9.5W)**
	1,071	**L1d**	**9W GU24 base LEDs provided for hardwired fixtures**
	1,090	**L5a**	**8.5W LED 2 pin bulbs provided for hardwired fixtures**
	830	**L5b**	**8.5W LED 4 pin bulbs provided for hardwired fixtures**
	40	**L6**	**Candelabra LEDs provided for hard-wired fixtures (7W)**
	132	**LC3**	**11W LED porch ceiling fixture**
	954	**RL4 (2')**	**2' Type C LED Tubes with Remote Driver**
	20	**RL5 (3')**	**3' Type C LED Tubes with Remote Driver**
	3,904	**RL6 (4')**	**4' Type C LED Tubes with Remote Driver**
	119	**RS1**	**8W LED under cabinet fixtures**
	679	**WP5**	**9W LED wall sconces**

The existing in-unit lighting is a mixture of incandescents, CFLs, and linear fluorescents. The efficiency measure is to replace these with LEDs. It is recommended that the hardwire screw-in fixtures are re-lamped with replacement 9.5 watt LED bulbs which will provide equal or greater light output to the existing light bulbs (minimum 800 lumens), with comparable shape and distribution. All LED lamps for in-unit applications shall be 2700°K (warm white). Some units also have linear fluorescent ceiling or vanity fixtures. It is recommended that these be re-lamped with LED tubes. The installing contractor will need to verify the exact number and location of fixtures to be remediated. Any surplus LED tubes can be delivered to SAHA as replacement stock.

There are some sites at which candelabra base, 2-pin, 4-pin, or GU24 fixtures exist. There are recommended replacement bulbs for each of these types in the specifications, but it is up to the contractor to determine which is appropriate for each fixture.

At Lewis Chatham, there are under cabinet fixtures in the kitchens. It is recommended that these be replaced with LED under cabinet fixtures. It is the contractor's responsibility to coordinate with SAHA on the mounting location of these new fixtures.

At Cross Creek, there are ceiling fixtures on the front and back porches of each unit. It is recommended that these be replaced with new LED ceiling fixtures.

There are front and/or back door wall sconces at a number of sites that should be replaced with LED wall sconces.

Improvements to Operations and Maintenance:

This measure will have no impact on operating or maintenance costs. No repairs are required for this measure to be effective and no new skills are required.

Impacts to Residents:

LED bulbs last longer than incandescent and fluorescent bulbs, reducing the frequency with which tenants have burned out lights.

Pricing and Site-Specific Installation Notes to Contractor:

Basis of design products are listed in the specification. Quantities are based on a 10% sample of units and actual quantities may vary. Please provide pricing based on counts listed in the table above. Also,

provide a per unit add/deduct (material and labor) for fixtures and lamps. Please provide an allowance as a separate line item for the installation of an additional 10% of lamps. The positioning of any new lighting should be cleared with SAHA prior to installation. Any concerns with retrofit mounting location, matching existing lighting distribution, or meeting electrical requirements should be coordinated with SAHA prior to install or purchase of materials. After installation, please leave a limited supply of each LED bulb type for the maintenance staff at each property. Additionally, to reduce impact on residents, the contractor must be appropriately staffed to allow the installation crew to install ECMs at an efficient pace.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									
		Water & Sewer			Electricity			Natural Gas			Total Energy Savings
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Villa Veramendi	HE Lighting - In Unit	-	-	-	176,762	$ 0.11547	$ 20,411	-	-	-	$ 20,411
Sun Park Lane	HE Lighting - In Unit	-	-	-	36,486	$ 0.12154	$ 4,434	-	-	-	$ 4,434
Frank Hornsby	HE Lighting - In Unit	-	-	-	36,866	$ 0.11429	$ 4,213	-	-	-	$ 4,213
Mission Park	HE Lighting - In Unit	-	-	-	97,344	$ 0.11546	$ 11,239	-	-	-	$ 11,239
Tarry Towne	HE Lighting - In Unit	-	-	-	74,938	$ 0.10080	$ 7,554	-	-	-	$ 7,554
Escondida	HE Lighting - In Unit	-	-	-	7,099	$ 0.10080	$ 716	-	-	-	$ 716
Williamsburg	HE Lighting - In Unit	-	-	-	10,169	$ 0.12572	$ 1,278	-	-	-	$ 1,278
Matt Garcia	HE Lighting - In Unit	-	-	-	43,006	$ 0.11376	$ 4,892	-	-	-	$ 4,892
Blanco	HE Lighting - In Unit	-	-	-	50,805	$ 0.09560	$ 4,857	-	-	-	$ 4,857
Lewis Chatham	HE Lighting - In Unit	-	-	-	29,501	$ 0.09080	$ 2,679	-	-	-	$ 2,679
Linda Lou	HE Lighting - In Unit	-	-	-	1,960	$ 0.12941	$ 254	-	-	-	$ 254
Riverside Apts	HE Lighting - In Unit	-	-	-	60,482	$ 0.11575	$ 7,001	-	-	-	$ 7,001
Linda Lou	HE Lighting - In Unit	-	-	-	53,924	$ 0.19827	$ 10,691	-	-	-	$ 10,691
Midway	HE Lighting - In Unit	-	-	-	13,549	$ 0.12400	$ 1,680	-	-	-	$ 1,680
Madonna	HE Lighting - In Unit	-	-	-	55,287	$ 0.12471	$ 6,895	-	-	-	$ 6,895
Sahara Ramsey	HE Lighting - In Unit	-	-	-	12,580	$ 0.11690	$ 1,471	-	-	-	$ 1,471
Cheryl West	HE Lighting - In Unit	-	-	-	68,295	$ 0.11705	$ 7,994	-	-	-	$ 7,994
T. L. Shaley	HE Lighting - In Unit	-	-	-	43,285	$ 0.11652	$ 5,043	-	-	-	$ 5,043
Jewett Circle	HE Lighting - In Unit	-	-	-	36,439	$ 0.10460	$ 3,812	-	-	-	$ 3,812
Col. Cisneros	HE Lighting - In Unit	-	-	-	42,069	$ 0.11327	$ 4,765	-	-	-	$ 4,765
Highview Apts	HE Lighting - In Unit	-	-	-	58,577	$ 0.11722	$ 6,866	-	-	-	$ 6,866
William Sinkin	HE Lighting - In Unit	-	-	-	42,207	$ 0.11951	$ 5,044	-	-	-	$ 5,044
Cross Creek	HE Lighting - In Unit	-	-	-	59,008	$ 0.11713	$ 6,912	-	-	-	$ 6,912
Morris C. Beldon	HE Lighting - In Unit	-	-	-	26,706	$ 0.11449	$ 3,058	-	-	-	$ 3,058
L.C. Rutledge	HE Lighting - In Unit	-	-	-	51,632	$ 0.11689	$ 6,035	-	-	-	$ 6,035
Westway	HE Lighting - In Unit	-	-	-	140,869	$ 0.11576	$ 16,307	-	-	-	$ 16,307
H.B. Gonzalez	HE Lighting - In Unit	-	-	-	44,439	$ 0.11461	$ 5,093	-	-	-	$ 5,093
Pin Oak II	HE Lighting - In Unit	-	-	-	21,651	$ 0.11688	$ 2,531	-	-	-	$ 2,531
Lila Cockrell	HE Lighting - In Unit	-	-	-	53,855	$ 0.11308	$ 6,090	-	-	-	$ 6,090
South San	HE Lighting - In Unit	-	-	-	19,402	$ 0.11405	$ 2,213	-	-	-	$ 2,213
Raymundo Rangel	HE Lighting - In Unit	-	-	-	11,156	$ 0.11316	$ 1,262	-	-	-	$ 1,262
Mirasol Homes	HE Lighting - In Unit	-	-	-	175,874	$ 0.11584	$ 20,373	-	-	-	$ 20,373
Mirasol Townhomes	HE Lighting - In Unit	-	-	-	25,673	$ 0.11551	$ 2,965	-	-	-	$ 2,965
Mirasol Cottages	HE Lighting - In Unit	-	-	-	16,185	$ 0.11512	$ 1,863	-	-	-	$ 1,863
Christ the King	HE Lighting - In Unit	-	-	-	25,959	$ 0.11380	$ 2,954	-	-	-	$ 2,954
Spring View Scat.	HE Lighting - In Unit	-	-	-	11,206	$ 0.11560	$ 1,295	-	-	-	$ 1,295
Spring View	HE Lighting - In Unit	-	-	-	118,731	$ 0.11520	$ 13,678	-	-	-	$ 13,678
Spring View Sr.	HE Lighting - In Unit	-	-	-	32,617	$ 0.11355	$ 3,704	-	-	-	$ 3,704
Pin Oak I	HE Lighting - In Unit	-	-	-	35,854	$ 0.12150	$ 4,356	-	-	-	$ 4,356

Calculation Methodology:

The savings is evaluated by multiplying the change in lighting load by the typical runtime hours as shown.

$$kWh\ Savings = (Existing\ Load - New\ Load) \times Hrs \times Nbr\ Lamps \times \frac{kW}{1000W}$$

Existing Load = Wattage of Existing Lamp/Fixture

New Load = Wattage of New Lamp/Fixture

Hrs – Annual hours of operation by space time

Nbr Lamps – Number of lamps/fixtures to be replaced

For Authority paid sites, all savings calculation details can be found within the "SAHA Phase II Savings Calculator" excel spreadsheet that has been provided as a supplement to this report. Resident paid site details can be found within the "SAHA EPC Phase II RPU Calculator".

5.2.2 Common Area Lighting Retrofit – ECM 2-220

Common area lighting efficiency opportunities were found at the following sites.

Blanco

Incandescent screw-in candelabra bulbs were found in the community room and laundry rooms. It is recommended that these be replaced with LED bulbs with similar bases.

There are 2' T12 fixtures in the elevators. 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.

CFL and incandescent ceiling surface mount fixtures were found in the laundry rooms and closets. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the corridors, lobby, offices, kitchen, stairwells, and storage areas. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures, wrap fixtures, or recessed fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
Candelabra-FN-3	Ceiling Fan Candelabra	Community room	7W LED candelabra bulb	L6	18 bulbs
Candelabra-FN-3	Ceiling Fan Candelabra	Laundry room	7W LED candelabra bulb	L6	3 bulb
Candelabra-FN-3	Ceiling Fan Candelabra	Laundry room 2-4	7W LED candelabra bulb	L6	9 bulbs
T12M2-SM-2	20W 2' T12 Magnetic Ballast Surface Mount Fixture	Elevators	2' Type C LED Tube with Remote Driver	RL4 (2')	8 bulbs
CSB-SM-2	14W Screw Base CFL Surface Mount Fixture	Laundry room	14W 12" round LED fixture	RO2 (12")	5 fixtures
ISB-SM-1	60W Incandescent Surface Mount Fixture	Closets	14W 12" round LED fixture	RO2 (12")	6 fixtures
CSB-SM-2	14W Screw Base CFL Surface Mount Fixture	Laundry room 2-4	22W 16" round LED fixture	RO3 (16")	6 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-RT-2	32W 4' T8 Electric Ballast Recessed Troffer	Corridor 1 west	36W 2'x4' recessed LED fixture	RR3	11 fixtures
T8E4-RT-2	32W 4' T8 Electric Ballast Recessed Troffer	Corridor 1 east	36W 2'x4' recessed LED fixture	RR3	11 fixtures
T8E4-RT-2	32W 4' T8 Electric Ballast Recessed Troffer	Corridor 2-4 W	36W 2'x4' recessed LED fixture	RR3	14 fixtures
T8E4-RT-2	32W 4' T8 Electric Ballast Recessed Troffer	Corridor 2-4 E	36W 2'x4' recessed LED fixture	RR3	13 fixtures
T8E4-RT-4	32W 4' T8 Electric Ballast Recessed Troffer	Lobby	49W 2'x4' recessed LED fixture	RR4	17 fixtures
T12M4-RT-	40W 4' T12 Magnetic Ballast Recessed Troffer	Bathroom	49W 2'x4' recessed LED fixture	RR4	1 fixture
T8E4-RT-4	32W 4' T8 Electric Ballast Recessed Troffer	Office 1	49W 2'x4' recessed LED fixture	RR4	5 fixtures
T8E4-RT-	32W 4' T8 Electric Ballast Recessed Troffer	Office 2	49W 2'x4' recessed LED fixture	RR4	1 fixture
T8E4-RT-	32W 4' T8 Electric Ballast Recessed Troffer	Storage	49W 2'x4' recessed LED fixture	RR4	2 fixtures
T5E1-SM-1	8W 1' T5 Electric Ballast Surface Mount Fixture	Kitchen	8W LED under cabinet	RS1	1 fixture
T5E2-SM-1	13W 2' T5 Electric Ballast Surface Mount Fixture	Kitchen	8W LED under cabinet	RS1	6 fixtures
T8E4-SM-2	W 4' T8 Electric Ballast Surface Mount Fixture	Community room	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M2-SM-1	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Storage 2-4	36W 4' LED surface mounted wrap	RW1	3 fixtures
T12M2-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Lobby 2-4	36W 4' LED surface mounted wrap	RW1	18 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Community room	50W 4' LED wide surface mounted wrap	RW3	16 fixtures
T12E4-SM-	40W 4' T12 Electric Ballast Surface Mount Fixture	Bathroom	50W 4' LED wide surface mounted wrap	RW3	1 fixture
T12M2-SM-2	20W 2' T12 Magnetic Ballast Surface Mount Fixture	Stairwell	25W 2' LED wide surface mounted wrap	RW4	7 fixtures
T12M2-SM-2	20W 2' T12 Magnetic Ballast Surface Mount Fixture	Stairwell west	25W 2' LED wide surface mounted wrap	RW4	7 fixtures
T12M2-SM-2	20W 2' T12 Magnetic Ballast Surface Mount Fixture	Stairwell east	25W 2' LED wide surface mounted wrap	RW4	11 fixtures

Cheryl West

Incandescent screw-in bulbs were found in the offices and bathroom. It is recommended that these be replaced with LED bulbs with similar bases.

Incandescent screw-in candelabra bulbs were found in the offices. It is recommended that these be replaced with LED bulbs with similar bases.

Linear fluorescent fixtures were found in the corridors, community room, kitchen, break room and bathroom. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-2	60W Incandescent Surface Mount Fixture	Office 1	9.5W LED Bulb	L1	2 bulbs
ISB-SM-2	60W Incandescent Surface Mount Fixture	Office 2	9.5W LED Bulb	L1	4 bulbs
ISB-SM-2	60W Incandescent Surface Mount Fixture	Bathroom	9.5W LED Bulb	L1	2 bulbs
ISB-SM-2	60W Incandescent Surface Mount Fixture	Office 1	9.5W LED Bulb	L1	2 bulbs
ISB-FN-3	40W Incandescent Ceiling Fan	Office 1	7W LED candelabra bulb	L6	3 bulb

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-FN-3	40W Incandescent Ceiling Fan	Office 2	7W LED candelabra bulb	L6	3 bulb
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Corridor	47W 4' LED surface mounted wrap	RW2	2 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Corridor	47W 4' LED surface mounted wrap	RW2	1 fixture
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Community room	47W 4' LED surface mounted wrap	RW2	8 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Kitchen	47W 4' LED surface mounted wrap	RW2	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Break room	47W 4' LED surface mounted wrap	RW2	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Bathroom	47W 4' LED surface mounted wrap	RW2	1 fixture

Christ the King

Incandescent screw-in bulbs were found in the office closet and kitchen stove. It is recommended that these be replaced with LED bulbs with similar bases.

There are 4' T12 fixtures in the elevators and community room. 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.

Linear fluorescent fixtures were found in the kitchen, bathroom, laundry room, office, mechanical, electrical, and elevator rooms, and storage areas. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures and wrap fixtures.

T12 vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

There are CFL wall fixtures in the main entry vestibule. It is recommended that these be replaced with LED wall sconces.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount Fixture	Office closet	9.5W LED Bulb	L1	1 bulb

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	40W Incandescent Stove Fixture	Kitchen	9.5W LED Bulb	L1	1 bulb
T12M4-SM-3	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator	4' Type C LED Tube with Remote Driver	RL6 (4')	3 bulb
T12M4-SM-1	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	4' Type C LED Tube with Remote Driver	RL6 (4')	16 bulbs
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Kitchen pantry	32W 4' LED surface mounted strip light	RS4	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Storage	32W 4' LED surface mounted strip light	RS4	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Electrical room	32W 4' LED surface mounted strip light	RS4	3 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Mechanical room	32W 4' LED surface mounted strip light	RS4	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Bathroom	36W 4' LED surface mounted wrap	RW1	3 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Bathroom	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	4 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 1	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Kitchen	50W 4' LED wide surface mounted wrap	RW3	1 fixture
T12M2-SM-1	40W 2' T12 Magnetic Ballast Surface Mount Fixture	Bathroom	18W 2' LED vanity	V1	2 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-2	14W Screw Base CFL Surface Mount Fixture	Main entry vestibule	10W LED wall sconce	WS1	3 fixtures

Col. Cisneros

CFL screw-in and CFL 4-pin bulbs were found in the storage room and lobby. It is recommended that these be replaced with LED bulbs with similar bases.

There are 4' T8 fixtures in the community room. 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.

Linear fluorescent fixtures were found in the maintenance room, bathrooms, offices, kitchen, and laundry room. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures or wrap fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Storage room 1	9.5W LED Bulb	L1	1 bulb
C4P-CN-1	26W 4-Pin CFL Can Light	Lobby	12W LED 4 pin bulb	L5c	8 bulbs
T8E4-PN-2	32W 4' T8 Electric Ballast Pendant Fixture	Community room	4' Type C LED Tube with Remote Driver	RL6 (4')	26 bulbs
T12M8-SM-2	96W 8' T12 Magnetic Ballast Surface Mount Fixture	Maintenance room	57W 1'x8' LED surface mounted fixture	RS6	2 fixtures
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Bathroom	47W 4' LED surface mounted wrap	RW2	2 fixtures
T8M4-SM-4	32W 4' T8 Magnetic Ballast Surface Mount Fixture	Office 1+2	47W 4' LED surface mounted wrap	RW2	3 fixtures
T8M4-SM-2	32W 4' T8 Magnetic Ballast Surface Mount Fixture	Office 1+2	47W 4' LED surface mounted wrap	RW2	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Bathroom	47W 4' LED surface mounted wrap	RW2	1 fixture

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8M4-SM-2	32W 4' T8 Magnetic Ballast Surface Mount Fixture	Bathroom	47W 4' LED surface mounted wrap	RW2	1 fixture
T8M4-SM-4	32W 4' T8 Magnetic Ballast Surface Mount Fixture	Kitchen	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T8M4-SM-4	32W 4' T8 Magnetic Ballast Surface Mount Fixture	Kitchen	50W 4' LED wide surface mounted wrap	RW3	1 fixture
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Laundry room	50W 4' LED wide surface mounted wrap	RW3	2 fixtures

Cross Creek

An incandescent screw-in was found in the kitchen stove hood. It is recommended that this be replaced with an LED bulb with a similar base.

CFL ceiling surface mount fixtures were found in the storage areas. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the maintenance room, community room, and offices. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

CFL vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SV-1	40W Incandescent Stove	Kitchen	9.5W LED Bulb	L1	1 bulb
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Storage	14W 12" round LED fixture	RO2 (12")	3 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Maintenance room	36W 4' LED surface mounted wrap	RW1	6 fixtures
T8M4-SM-2	32W 4' T8 Magnetic Ballast Surface Mount Fixture	Maintenance room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	47W 4' LED surface mounted wrap	RW2	7 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	47W 4' LED surface mounted wrap	RW2	3 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Office 1	47W 4' LED surface mounted wrap	RW2	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 1	47W 4' LED surface mounted wrap	RW2	1 fixture
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Office 2	47W 4' LED surface mounted wrap	RW2	1 fixture
CSB-VT-4	14W Screw Base CFL Vanity	Bathroom	34W 4' LED vanity	V2	2 fixtures

Escondida

CFL screw-in bulbs were found in the community room and laundry room ceiling fans. It is recommended that these be replaced with LED bulbs with similar bases.

CFL and incandescent ceiling surface mount fixtures were found in the boiler room, mechanical room, and storage room. In the community room, there are T-12 u-lamp ceiling fixtures. It is recommended that all of these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the elevator room and bathroom. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures or wrap fixtures.

CFL vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-FN-3	13W Screw Base CFL Ceiling Fan	Community room	9.5W LED Bulb	L1	6 bulbs
CSB-FN-1	13W Screw Base CFL Ceiling Fan	Laundry room	9.5W LED Bulb	L1	1 bulb
ISB-SM-1	60W Incandescent Surface Mount Fixture	Boiler room	14W 12" round LED fixture	RO2 (12")	1 fixture
CSB-SM-1	13W Screw Base CFL Surface Mount Fixture	Mechanical room	14W 12" round LED fixture	RO2 (12")	1 fixture
CSB-SM-2	13W Screw Base CFL Surface Mount Fixture	Storage	22W 16" round LED fixture	RO3 (16")	2 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12MU-SM-2	40W T12 U-lamp Magnetic Ballast Surface Mount Fixture	Community room	32W 20" round LED fixture	RO4 (20")	6 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator room	32W 4' LED surface mounted strip light	RS4	2 fixtures
T12M2-SM-2	40W 2' T12 Magnetic Ballast Surface Mount Fixture	Bathroom	36W 4' LED surface mounted wrap	RW1	1 fixture
CSB-VT-3	13W Screw Base CFL Vanity	Bathroom	18W 2' LED vanity	V1	1 fixture

Frank Hornsby

There are 2' T8 fixtures and 4' and 8' T12 fixtures in the elevator and community room. 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.

CFL and incandescent ceiling surface mount fixtures were found in the storage areas and boiler room. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

A 4' T12 fixture was found in the laundry room. It is recommended that it be replaced with an LED strip fixture.

Linear fluorescent fixtures were found in the mail room, office, community room, laundry room, bathroom, kitchen, and electrical room. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Six or eight foot T12 vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with 2' LED vanity fixtures, a fixture above each sink.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E2-SM-2	17W 2' T8 Electric Ballast Surface Mount Fixture	Community room	2' Type C LED Tube with Remote Driver	RL4 (2')	2 bulbs
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	4' Type C LED Tube with Remote Driver	RL6 (4')	30 bulbs
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator	4' Type C LED Tube with Remote Driver	RL6 (4')	4 bulbs
T12M6-SM-2	57W 8' T12 Magnetic Ballast Surface Mount Fixture	Community room	8' Type C LED Tube with Remote Driver	RL7 (8')	16 bulbs

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-2	60W Incandescent Surface Mount Fixture	Storage	22W 16” round LED fixture	RO3 (16”)	1 fixture
CSB-SM-2	13W Screw Base CFL Surface Mount Fixture	Boiler room	22W 16” round LED fixture	RO3 (16”)	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Laundry room	32W 4’ LED surface mounted strip light	RS4	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Mail room	36W 4’ LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Office 1	36W 4’ LED surface mounted wrap	RW1	7 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4’ LED surface mounted wrap	RW1	12 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4’ LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Laundry room	36W 4’ LED surface mounted wrap	RW1	3 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Bathroom	36W 4’ LED surface mounted wrap	RW1	4 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Bathroom	36W 4’ LED surface mounted wrap	RW1	3 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	kitchen storage	36W 4’ LED surface mounted wrap	RW1	3 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Electrical room	36W 4’ LED surface mounted wrap	RW1	4 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Elevator room	36W 4’ LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-4	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Electrical room	47W 4’ LED surface mounted wrap	RW2	6 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Kitchen	50W 4' LED wide surface mounted wrap	RW3	7 fixtures
T12M2-SM-2	20W 2' T12 Magnetic Ballast Surface Mount Fixture	Community room	25W 2' LED wide surface mounted wrap	RW4	1 fixture
T12M6-SM-2	57W 6' T12 Magnetic Ballast Vanity Fixture	Bathroom	2x 18W 2' LED vanity	V1	4 fixtures

HB Gonzalez

Incandescent screw-in bulbs were found in the laundry room and community room ceiling fans. It is recommended that these be replaced with LED bulbs with similar bases.

There are 4' T12 fixtures in the elevators. 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.

Incandescent ceiling surface mount fixtures were found in the closets and mail room. In the lobby and community room, there are T-12 u-lamp ceiling fixtures. It is recommended that all of these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the bathroom, maintenance building, boiler room, back lobby, kitchen, corridor, office, and storage room. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures, LED wrap fixtures, or LED recessed fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-FN-3	60W Incandescent Ceiling Fan	Laundry rooms	9.5W LED Bulb	L1	9 bulbs
ISB-FN-3	60W Incandescent Ceiling Fan	Community room	9.5W LED Bulb	L1	9 bulbs
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator	4' Type C LED Tube with Remote Driver	RL6 (4')	4 bulbs
ISB-SM-1	60W Incandescent Surface Mount Fixture	Janitor closet	14W 12" round LED fixture	RO2 (12")	3 fixtures
ISB-SM-2	60W Incandescent Surface Mount Fixture	Storage closet	14W 12" round LED fixture	RO2 (12")	1 fixture
ISB-SM-2	60W Incandescent Surface Mount Fixture	Mail room	22W 16" round LED fixture	RO3 (16")	1 fixture

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12MU-SM-2	40W T12 U-lamp Magnetic Ballast Surface Mount Fixture	Lobby	32W 20” round LED fixture	RO4 (20”)	4 fixtures
T12MU-SM-2	40W T12 U-lamp Magnetic Ballast Surface Mount Fixture	Community room	32W 20” round LED fixture	RO4 (20”)	6 fixtures
T12M2-SM-4	40W 2’ T12 Magnetic Ballast Surface Mount Fixture	Bathroom	32W 2’x2’ surface LED fixture	RR6	2 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Maintenance building	32W 4’ LED surface mounted strip light	RS4	3 fixtures
T12M8-SM-2	96W 8’ T12 Magnetic Ballast Surface Mount Fixture	Boiler room	57W 1’x8’ LED surface mounted fixture	RS6	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Back building lobby	36W 4’ LED surface mounted wrap	RW1	3 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Mechanical room	36W 4’ LED surface mounted wrap	RW1	1 fixture
T12M4-SM-4	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Back building lobby	50W 4’ LED wide surface mounted wrap	RW3	3 fixtures
T12M4-SM-4	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Kitchen	50W 4’ LED wide surface mounted wrap	RW3	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Corridor	50W 4’ LED wide surface mounted wrap	RW3	1 fixture
T12M4-SM-4	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Office 1	50W 4’ LED wide surface mounted wrap	RW3	1 fixture
T12M4-SM-4	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Office 2	50W 4’ LED wide surface mounted wrap	RW3	2 fixtures
T12M4-SM-4	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Storage room	50W 4’ LED wide surface mounted wrap	RW3	6 fixtures

Highview

Linear fluorescent fixtures were found in the community room, maintenance room, corridor, bathroom, office, and storage areas. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures or LED wrap fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M8-SM-2	40W 8' T12 Magnetic Ballast Surface Mount Fixture	Storage	57W 1'x8' LED surface mounted fixture	RS6	2 fixtures
T12M8-SM-2	40W 8' T12 Magnetic Ballast Surface Mount Fixture	Maintenance room	57W 1'x8' LED surface mounted fixture	RS6	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Com Corridor	36W 4' LED surface mounted wrap	RW1	5 fixtures
T12M8-SM-2	40W 8' T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4' LED surface mounted wrap	RW1	6 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Bathroom	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Maintenance room	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 1	47W 4' LED surface mounted wrap	RW2	1 fixture

Jewett Circle

Incandescent screw-in bulbs were found in the corridors, offices, and bathroom, and CFL 4-pin can lights were found in the corridors and community room. It is recommended that these be replaced with LED bulbs with similar bases.

There are 2' and 4' T12 fixtures in the elevators. 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.

Incandescent ceiling surface mount fixtures were found in the corridors, bathroom, maintenance, and storage areas. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the offices, community room, mechanical room, maintenance room, and laundry room. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures, wrap fixtures, or recessed fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SC-2	60W Incandescent Sconce	Corridor	9.5W LED Bulb	L1	28 bulbs
ISB-FN-4	60W Incandescent Ceiling Fan	Office 1	9.5W LED Bulb	L1	4 bulb
ISB-FN-3	60W Incandescent Ceiling Fan	Office 1	9.5W LED Bulb	L1	3 bulb
ISB-SC-1	60W Incandescent Sconce	Bathroom	9.5W LED Bulb	L1	2 bulbs
C4P-CN-2	13W 4-Pin CFL Can Light	Corridor	8.5W LED 4 pin bulb	L5b	14 bulbs
C4P-CN-2	13W 4-Pin CFL Can Light	Community room	8.5W LED 4 pin bulb	L5b	24 bulbs
T12M2-RC-1	20W 2’ T12 Magnetic Ballast Recessed Fixture	Elevator	2’ Type C LED Tube with Remote Driver	RL4 (2’)	4 bulbs
T12M4-RC-1	40W 4’ T12 Magnetic Ballast Recessed Fixture	Elevator	4’ Type C LED Tube with Remote Driver	RL6 (4’)	4 bulbs
ISB-SM-1	60W Incandescent Surface Mount Fixture	Corridor	14W 12” round LED fixture	RO2 (12”)	1 fixture
ISB-SM-1	60W Incandescent Surface Mount Fixture	Bathroom	14W 12” round LED fixture	RO2 (12”)	1 fixture
ISB-SM-1	60W Incandescent Surface Mount Fixture	Maintenance	14W 12” round LED fixture	RO2 (12”)	1 fixture
ISB-SM-2	60W Incandescent Surface Mount Fixture	Storage	22W 16” round LED fixture	RO3 (16”)	4 fixtures
T8E2-RC-2	17W 2’ T8 Electric Ballast Recessed Fixture	Office 2	30W 2’x2’ recessed LED fixture	RR5	2 fixtures
T8E2-RC-2	17W 2’ T8 Electric Ballast Recessed Fixture	Community room	30W 2’x2’ recessed LED fixture	RR5	6 fixtures
T12MU2-SM-2	40W 2’ T12 U-lamp Magnetic Ballast Surface Mount Fixture	Office 1	32W 2’x2’ surface LED fixture	RR6	2 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-1	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 2	22W 4' LED surface mounted strip light	RS3	3 fixtures
T8E4-SM-1	32W 4' T8 Electric Ballast Surface Mount Fixture	Mechanical room	22W 4' LED surface mounted strip light	RS3	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator room	32W 4' LED surface mounted strip light	RS4	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Maintenance	32W 4' LED surface mounted strip light	RS4	7 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Maintenance	32W 4' LED surface mounted strip light	RS4	5 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Community room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Corridor	36W 4' LED surface mounted wrap	RW1	4 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	4 fixtures

LC Rutledge

Linear fluorescent fixtures were found in the offices, lobby, mechanical room, and community room. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

CFL vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 2	36W 4' LED surface mounted wrap	RW1	4 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Lobby	36W 4' LED surface mounted wrap	RW1	3 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Mechanical room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Mechanical room	36W 4' LED surface mounted wrap	RW1	6 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	50W 4' LED wide surface mounted wrap	RW3	13 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 1	50W 4' LED wide surface mounted wrap	RW3	3 fixtures
CSB-VT-2	13W Screw Base CFL Vanity	Bathroom	18W 2' LED vanity	V1	2 fixtures

Lewis Chatham

CFL 2-pin and 4-pin can lights were found in the corridors and bathroom. It is recommended that these be replaced with LED bulbs with similar bases.

There are 2' and 4' T8 fixtures in the elevator and mechanical room. 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.

CFL and incandescent ceiling surface mount fixtures were found in the mechanical room, basement, community room, and main entry vestibule. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the corridor, stairwell, offices, laundry room, break room, bathroom, community room, basement, and storage areas. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures or recessed fixtures.

T5 vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C4P-CN-1	13W 4-Pin CFL Can Light	Bathroom	8.5W LED 4 pin bulb	L5b	3 bulbs
C2P-CN-1	26W 2-Pin CFL Can Light	Corridor	12W LED 2 pin bulb	L5d	8 bulbs
T8E2-SM-2	17W 2' T8 Electric Ballast Surface Mount Fixture	Mechanical room	2' Type C LED Tube with Remote Driver	RL4 (2')	4 bulbs

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-RC-2	32W 4’ T8 Electric Ballast Recessed Fixture	Elevator	4’ Type C LED Tube with Remote Driver	RL6 (4’)	4 bulbs
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Mechanical room	4’ Type C LED Tube with Remote Driver	RL6 (4’)	4 bulbs
CPB-SM-1	18W GU24 CFL Surface Mount Fixture	Mechanical room	14W 12” round LED fixture	RO2 (12”)	3 fixtures
ISB-SM-1	60W Incandescent Surface Mount Fixture	Basement	14W 12” round LED fixture	RO2 (12”)	1 fixture
CPB-SM-2	18W GU24 CFL Surface Mount Fixture	Community room	22W 16” round LED fixture	RO3 (16”)	6 fixtures
C2P-SM-2	26W 2-Pin CFL Surface Mount Fixture	Main entry vestibule	32W 20” round LED fixture	RO4 (20”)	3 fixtures
T8E4-RC-2	32W 4’ T8 Electric Ballast Recessed Fixture	Storage	36W 2’x4’ recessed LED fixture	RR3	10 fixtures
T8E4-RC-2	32W 4’ T8 Electric Ballast Recessed Fixture	Electrical room	36W 2’x4’ recessed LED fixture	RR3	7 fixtures
T8E4-RC-4	32W 4’ T8 Electric Ballast Recessed Fixture	Corridor	49W 2’x4’ recessed LED fixture	RR4	179 fixtures
T8E4-RC-4	32W 4’ T8 Electric Ballast Recessed Fixture	Stairwell	49W 2’x4’ recessed LED fixture	RR4	12 fixtures
T8E4-RC-4	32W 4’ T8 Electric Ballast Recessed Fixture	Office 1	49W 2’x4’ recessed LED fixture	RR4	6 fixtures
T8E4-RC-4	32W 4’ T8 Electric Ballast Recessed Fixture	Office 2	49W 2’x4’ recessed LED fixture	RR4	4 fixtures
T8E4-RC-4	32W 4’ T8 Electric Ballast Recessed Fixture	Storage	49W 2’x4’ recessed LED fixture	RR4	13 fixtures
T8E4-RC-4	32W 4’ T8 Electric Ballast Recessed Fixture	Laundry room	49W 2’x4’ recessed LED fixture	RR4	12 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-RC-4	32W 4' T8 Electric Ballast Recessed Fixture	Break room	49W 2'x4' recessed LED fixture	RR4	1 fixture
T8E4-RC-4	32W 4' T8 Electric Ballast Recessed Fixture	Bathroom	49W 2'x4' recessed LED fixture	RR4	2 fixtures
T8E4-RC-4	32W 4' T8 Electric Ballast Recessed Fixture	Community room	49W 2'x4' recessed LED fixture	RR4	13 fixtures
T8E4-RC-4	32W 4' T8 Electric Ballast Recessed Fixture	Kitchen	49W 2'x4' recessed LED fixture	RR4	5 fixtures
C4P-RC-2	40W 4-Pin CFL Recessed Fixture	Corridor	30W 2'x2' recessed LED fixture	RR5	5 fixtures
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Basement	36W 4' LED surface mounted wrap	RW1	38 fixtures
T5E2-VT-2	14W 2' T5 Electric Ballast Vanity	Bathroom	18W 2' LED vanity	V1	1 fixture

Lila Cockerell

Incandescent screw-in bulbs were found in the bathroom, community room, and storage closet, and CFL 2-pin and 4-pin can lights were found in the community room, lobby, kitchen, and storage room. It is recommended that these be replaced with LED bulbs with similar bases.

There are 4' T8 and T12 fixtures in the elevators. 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.

CFL and incandescent ceiling surface mount fixtures as well as T9 circline ceiling fixtures were found in the kitchen and maintenance building. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the offices, lobbies, laundry rooms, elevator room, and storage areas. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures, wrap fixtures, and recessed fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-3	60W Screw Base Incandescent Vanity	Bathroom	9.5W LED Bulb	L1	6 bulbs
ISB-FN-4	60W Incandescent Ceiling Fan	Community room	9.5W LED Bulb	L1	4 bulb

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount	Storage closet	9.5W LED Bulb	L1	1 bulb
C4P-CN-1	26W 4-Pin CFL Can Light	Community room	12W LED 4 pin bulb	L5c	16 bulbs
C2P-CN-1	26W 2-Pin CFL Can Light	Lobby 1st floor	12W LED 2 pin bulb	L5d	16 bulbs
C2P-CN-2	26W 2-Pin CFL Can Light	Kitchen	12W LED 2 pin bulb	L5d	6 bulbs
C2P-CN-2	26W 2-Pin CFL Can Light	Storage room	12W LED 2 pin bulb	L5d	12 bulbs
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Elevator	4’ Type C LED Tube with Remote Driver	RL6 (4’)	2 bulbs
T12M4-SM-4	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Elevator	4’ Type C LED Tube with Remote Driver	RL6 (4’)	8 bulbs
T9-SM-1	22W T9 Circline Surface Mount Fixture	Kitchen	14W 12” round LED fixture	RO2 (12”)	1 fixture
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Maintenance building	14W 12” round LED fixture	RO2 (12”)	1 fixture
ISB-SM-1	60W Incandescent Surface Mount	Maintenance building	14W 12” round LED fixture	RO2 (12”)	2 fixtures
CSB-SM-2	14W Screw Base CFL Surface Mount Fixture	Maintenance building	22W 16” round LED fixture	RO3 (16”)	1 fixture
T8E4-RC-4	32W 4’ T8 Electric Ballast Recessed Fixture	Office 1, 2	49W 2’x4’ recessed LED fixture	RR4	2 fixtures
T12M4-SM-4	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Elevator room	32W 4’ LED surface mounted strip light	RS4	1 fixture
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Boiler room	32W 4’ LED surface mounted strip light	RS4	1 fixture
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Office 3	36W 4’ LED surface mounted wrap	RW1	1 fixture

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Lobby 2nd/3rd floor	36W 4' LED surface mounted wrap	RW1	3 fixtures
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Lobby 2nd/3rd floor	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Lobby 3rd floor	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Storage 2nd/3rd floor	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Maintenance building	36W 4' LED surface mounted wrap	RW1	1 fixture
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Laundry room 1st floor	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Recessed Fixture	Laundry 2nd floor	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T12E4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Laundry 3rd floor	50W 4' LED wide surface mounted wrap	RW3	2 fixtures

Linda Lou

Incandescent screw-in bulbs were found in the DHW heater closets. It is recommended that these be replaced with LED bulbs with similar bases.

An incandescent ceiling surface mount fixture was found in the laundry room. It is recommended that it be replaced with a round LED ceiling fixture.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount Fixture	DHW	9.5W LED Bulb	L1	10 bulbs
ISB-SM-1	60W Incandescent Surface Mount Fixture	Laundry room	14W 12" round LED fixture	RO2 (12")	1 fixture

Madonna

CFL screw-in bulbs were found in the carport storage, community room, and laundry room, and CFL 4-pin can lights were found in the community room and office. It is recommended that these be replaced with LED bulbs with similar bases.

CFL and incandescent ceiling surface mount fixtures were found in the office and boiler room. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

There are T8 under cabinet fixtures in the kitchen. It is recommended that these be replaced with LED under cabinet fixtures.

Linear fluorescent fixtures were found in the carport office, laundry room, and storage areas. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

T12 vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-1	13W Screw Base CFL Surface Mount Fixture	carport storage 1,2	9.5W LED Bulb	L1	4 bulbs
CSB-Pendant-3	13W Screw Base CFL Pendant	Community room	9.5W LED Bulb	L1	12 bulbs
CSB-FN-1	13W Screw Base CFL Ceiling Fan	Laundry room	9.5W LED Bulb	L1	2 bulbs
C4P-CN-1	26W 4-Pin CFL Can Light	Community room	12W LED 4 pin bulb	L5c	16 bulbs
C4P-CN-1	26W 4-Pin CFL Can Light	Office 1	12W LED 4 pin bulb	L5c	3 bulbs
CSB-SM-1	13W Screw Base CFL Surface Mount Fixture	Carport 2 office	14W 12” round LED fixture	RO2 (12”)	1 fixture
mix of isb csb-SM-1	60/13W Incandescent/CFL Surface Mount Fixture	Boiler room	14W 12” round LED fixture	RO2 (12”)	5 fixtures
T8E3-SM-1	25W 3’ T8 Electric Ballast Surface Mount Fixture	Kitchen	11W LED under cabinet	RS1b	2 fixtures
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Carport 2 office	36W 4’ LED surface mounted wrap	RW1	1 fixture
T12E4-SM-2	40W 4’ T12 Electric Ballast Surface Mount Fixture	Storage	36W 4’ LED surface mounted wrap	RW1	1 fixture

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M2-VT-2	20W 2' T12 Magnetic Ballast Vanity	Bathroom	18W 2' LED vanity	V1	1 fixture

Matt Garcia

CFL and incandescent screw-in bulbs were found in the storage areas, bathroom, and front desk. It is recommended that these be replaced with LED bulbs with similar bases.

There are 4' T8 fixtures in the elevators. 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.

CFL and incandescent ceiling surface mount fixtures were found in the DHW heater closets, community rooms, and stairwell. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the maintenance room, offices, laundry room, kitchen, stairwell, and lobby. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount Fixture	Storage 1	9.5W LED Bulb	L1	1 bulb
ISB-SM-1	60W Incandescent Surface Mount Fixture	Storage 2	9.5W LED Bulb	L1	1 bulb
ISB-VT-2	40W Incandescent Vanity	Bathroom	9.5W LED Bulb	L1	4 bulbs
ISB-SM-1	40W Incandescent Surface Mount Fixture	Cooling closet	9.5W LED Bulb	L1	1 bulb
CSB-SC-1	23W Screw Base CFL Sconce	Front desk	16.5W LED Bulb	L2	2 bulbs
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Elevator	4' Type C LED Tube with Remote Driver	RL6 (4')	2 bulbs
ISB-SM-1	60W Incandescent Surface Mount Fixture	DHW room laundry 1, 2,3	14W 12" round LED fixture	RO2 (12")	3 fixtures
ISB-SM-2	60W Incandescent Surface Mount Fixture	Community room 2	22W 16" round LED fixture	RO3 (16")	3 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-2	60W Incandescent Surface Mount Fixture	Community room 3	22W 16” round LED fixture	RO3 (16”)	3 fixtures
CSB-SM-2	14W Screw Base CFL Surface Mount Fixture	Stairwell	22W 16” round LED fixture	RO3 (16”)	1 fixture
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Maintenance room	36W 4’ LED surface mounted wrap	RW1	1 fixture
T8M4-SM-2	32W 4’ T8 Magnetic Ballast Surface Mount Fixture	Maintenance room	36W 4’ LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Office 1	36W 4’ LED surface mounted wrap	RW1	4 fixtures
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Laundry room 1	36W 4’ LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Office 2	36W 4’ LED surface mounted wrap	RW1	3 fixtures
T8E4-SM-1	32W 4’ T8 Electric Ballast Surface Mount Fixture	Office 2	36W 4’ LED surface mounted wrap	RW1	1 fixture
T12E4-SM-2	40W 4’ T12 Electric Ballast Surface Mount Fixture	Kitchen / Dining area	36W 4’ LED surface mounted wrap	RW1	8 fixtures
T12E4-SM-2	40W 4’ T12 Electric Ballast Surface Mount Fixture	Kitchen storage	36W 4’ LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Laundry room 2	36W 4’ LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Laundry room 3	36W 4’ LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Stairwell	36W 4’ LED surface mounted wrap	RW1	2 fixtures
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Lobby	36W 4’ LED surface mounted wrap	RW1	11 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator room	36W 4' LED surface mounted wrap	RW1	1 fixture

Midway

CFL and incandescent screw-in bulbs were found in the storage areas. It is recommended that these be replaced with LED bulbs with similar bases.

A CFL ceiling surface mount fixture was found in the bathroom. It is recommended that it be replaced with a round LED ceiling fixture.

Linear fluorescent fixtures were found in the laundry room, community room, office, and corridor. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Incandescent vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Storage 1	9.5W LED Bulb	L1	1 bulb
ISB-SM-1	60W Incandescent Surface Mount Fixture	Storage 1	9.5W LED Bulb	L1	2 bulbs
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Storage 2	9.5W LED Bulb	L1	1 bulb
CSB-SM-2	14W Screw Base CFL Surface Mount Fixture	Bathroom	22W 16" round LED fixture	RO3 (16")	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4' LED surface mounted wrap	RW1	8 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 1	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Corridor	50W 4' LED wide surface mounted wrap	RW3	1 fixture

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-VT-2	60W Incandescent Vanity	Bathroom	18W 2' LED vanity	V1	1 fixture

Mirasol

Incandescent ceiling cans were found in the classroom, and it is recommended that these be re-lamped with LED bulbs.

Linear fluorescent fixtures were found in the corridor, office, break room, bathroom, storage areas, lobby, CPU lab, classroom, and maintenance areas. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures and recessed fixtures.

Incandescent and T8 vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-CN-1	60W Incandescent Can Light	Classroom	9.5W LED Bulb	L1	12 bulbs
T8E4-RC-2	32W 4' T8 Electric Ballast Recessed Fixture	Corridor	36W 2'x4' recessed LED fixture	RR3	15 fixtures
T8E4-RC-2	32W 4' T8 Electric Ballast Recessed Fixture	Office 1	36W 2'x4' recessed LED fixture	RR3	36 fixtures
T8E4-RC-2	32W 4' T8 Electric Ballast Recessed Fixture	Break room	36W 2'x4' recessed LED fixture	RR3	5 fixtures
T8E4-RC-2	32W 4' T8 Electric Ballast Recessed Fixture	Bathroom	36W 2'x4' recessed LED fixture	RR3	4 fixtures
T8E4-RC-2	32W 4' T8 Electric Ballast Recessed Fixture	Storage	36W 2'x4' recessed LED fixture	RR3	8 fixtures
T8E4-RC-4	32W 4' T8 Electric Ballast Recessed Fixture	Lobby	49W 2'x4' recessed LED fixture	RR4	8 fixtures
T8E4-RC-4	32W 4' T8 Electric Ballast Recessed Fixture	CPU Lab	49W 2'x4' recessed LED fixture	RR4	6 fixtures
T8E4-RC-4	32W 4' T8 Electric Ballast Recessed Fixture	Classroom	49W 2'x4' recessed LED fixture	RR4	12 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-RC-4	32W 4' T8 Electric Ballast Recessed Fixture	Bathroom	49W 2'x4' recessed LED fixture	RR4	2 fixtures
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Electrical room	36W 4' LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Closet	36W 4' LED surface mounted wrap	RW1	4 fixtures
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Electrical room	36W 4' LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Maintenance	36W 4' LED surface mounted wrap	RW1	24 fixtures
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Mechanical room	36W 4' LED surface mounted wrap	RW1	2 fixtures
ISB-VT-4	60W Incandescent Vanity	Bathroom	34W 4' LED vanity	V2	1 fixture
T8E4-VT-2	32W 4' T8 Electric Ballast Vanity	Bathroom	34W 4' LED vanity	V2	3 fixtures

Mission Park

There are (6) wall-mounted uplight fixtures in the community room with 400W metal halides. It is recommended that these be replaced with LED bulbs with similar bases.

There are 2-pin CFL can lights in the main entry vestibule, corridor, and storage. It is recommended that these be replaced with LED bulbs with similar bases.

Linear fluorescent fixtures were found in the storage areas, office, bathroom, kitchen, maintenance areas, laundry room, corridor, and community room. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures and recessed fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-Indirect-1	400W Metal Halide Wall Mounted Uplight Fixture	Community room	150W screw-in LED bulb	L10d	6 bulbs
C2P-CN-2	26W 2-Pin CFL Can Light	Main entry vestibule	12W LED 2 pin bulb	L5d	8 bulbs

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C2P-CN-2	26W 2-Pin CFL Can Light	Corridor	12W LED 2 pin bulb	L5d	12 bulbs
C2P-CN-2	26W 2-Pin CFL Can Light	Storage	12W LED 2 pin bulb	L5d	2 bulbs
T8E4-RC-2	32W 4’ T8 Electric Ballast Recessed Fixture	Storage	32W 1’x4’ recessed LED fixture	RR2	2 fixtures
T8E4-RC-3	32W 4’ T8 Electric Ballast Recessed Fixture	Office 1	36W 2’x4’ recessed LED fixture	RR3	13 fixtures
T8E4-RC-3	32W 4’ T8 Electric Ballast Recessed Fixture	Bathroom	36W 2’x4’ recessed LED fixture	RR3	6 fixtures
T8E4-RC-3	32W 4’ T8 Electric Ballast Recessed Fixture	Kitchen	36W 2’x4’ recessed LED fixture	RR3	2 fixtures
T8E4-RC-3	32W 4’ T8 Electric Ballast Recessed Fixture	Maintenance	36W 2’x4’ recessed LED fixture	RR3	2 fixtures
T8E4-RC-3	32W 4’ T8 Electric Ballast Recessed Fixture	Laundry room	36W 2’x4’ recessed LED fixture	RR3	4 fixtures
T12E2U-RC-2	40W 2’ T12 U-lamp Electric Ballast Recessed Fixture	Corridor	30W 2’x2’ recessed LED fixture	RR5	9 fixtures
T8E2U-RC-2	32W 2’ T8 U-lamp Electric Ballast Recessed Fixture	Community room	30W 2’x2’ recessed LED fixture	RR5	8 fixtures
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Main entry vestibule	36W 4’ LED surface mounted wrap	RW1	5 fixtures
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Bathroom	36W 4’ LED surface mounted wrap	RW1	6 fixtures
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Maintenance	36W 4’ LED surface mounted wrap	RW1	15 fixtures
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Mechanical room	36W 4’ LED surface mounted wrap	RW1	2 fixtures

MC Beldon

Incandescent ceiling surface mount fixtures were found in the bathroom and storage. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the mechanical room, bathroom, and community room. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount Fixture	Storage	14W 12" round LED fixture	RO2 (12")	2 fixtures
ISB-SM-1	60W Incandescent Surface Mount Fixture	Bathroom	14W 12" round LED fixture	RO2 (12")	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Mechanical room	36W 4' LED surface mounted wrap	RW1	3 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4' LED surface mounted wrap	RW1	6 fixtures
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Bathroom	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	47W 4' LED surface mounted wrap	RW2	8 fixtures

Pin Oak I

There are 4' T12 fixtures in the elevators. 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.

Incandescent ceiling surface mount fixtures were found in the mechanical room, lobby, and community room. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the community room, janitors' closets, mechanical room, kitchen, lobbies, elevator room, offices, craft room, and laundry room. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures, wrap fixtures, and recessed fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator	4' Type C LED Tube with Remote Driver	RL6 (4')	4 bulbs
ISB-SM-1	60W Incandescent Surface Mount Fixture	Mechanical room	14W 12" round LED fixture	RO2 (12")	2 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount Fixture	Lobby	14W 12" round LED fixture	RO2 (12")	14 fixtures
ISB-SM-1	60W Incandescent Surface Mount Fixture	Community room	14W 12" round LED fixture	RO2 (12")	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Recessed Troffer	Community room	49W 2'x4' recessed LED fixture	RR4	8 fixtures
T12M2-SM-2	20W 2' T12 Magnetic Ballast Surface Mount Fixture	Janitor 2,3	22W 2' LED surface mounted strip light	RS2	2 fixtures
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Mechanical room	32W 4' LED surface mounted strip light	RS4	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Kitchen	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Lobby	36W 4' LED surface mounted wrap	RW1	4 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12E4-SM-4	40W 4' T12 Electric Ballast Surface Mount Fixture	Office 1	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T12E4-SM-4	40W 4' T12 Electric Ballast Surface Mount Fixture	Office 2	50W 4' LED wide surface mounted wrap	RW3	3 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Craft	50W 4' LED wide surface mounted wrap	RW3	4 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Laundry room	50W 4' LED wide surface mounted wrap	RW3	3 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Lobby 3	50W 4' LED wide surface mounted wrap	RW3	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Lobby 2	50W 4' LED wide surface mounted wrap	RW3	1 fixture

Pin Oak II

Incandescent ceiling surface mount fixtures were found in the community room, bathroom, and mechanical room. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the community room and office. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Incandescent vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount Fixture	Community room	14W 12" round LED fixture	RO2 (12")	2 fixtures
ISB-SM-1	60W Incandescent Surface Mount Fixture	Bathroom	14W 12" round LED fixture	RO2 (12")	2 fixtures
ISB-SM-2	60W Incandescent Surface Mount Fixture	Mechanical room	22W 16" round LED fixture	RO3 (16")	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	50W 4' LED wide surface mounted wrap	RW3	5 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 1	50W 4' LED wide surface mounted wrap	RW3	4 fixtures
ISB-VT-4	60W Incandescent Vanity	Bathroom	34W 4' LED vanity	V2	2 fixtures

Raymundo Rangel

CFL screw-in bulbs were found in the community room, and CFL 2-pin can lights were found in the corridor. It is recommended that these be replaced with LED bulbs with similar bases.

Incandescent ceiling surface mount fixtures were found in the storage areas. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the laundry room, bathroom, kitchen, and office. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Incandescent vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-PN-1	14W Screw Base CFL Pendant Fixture	Community room	9.5W LED Bulb	L1	6 bulbs
C2P-CN-2	13W 2-Pin CFL Can Light	Corridor	8.5W LED 2 pin bulb	L5a	10 bulbs
ISB-SM-3	60W Incandescent Surface Mount Fixture	Storage	14W 12" round LED fixture	RO2 (12")	3 fixtures
T8E4-PN-1	32W 4' T8 Electric Ballast Pendant Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Bathroom	36W 4' LED surface mounted wrap	RW1	4 fixtures
T8E4-SM-3	32W 4' T8 Electric Ballast Surface Mount Fixture	Kitchen	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T12E4-SM-	40W 4' T12 Electric Ballast Surface Mount Fixture	Office 1	50W 4' LED wide surface mounted wrap	RW3	1 fixture
T8E4-SM-3	32W 4' T8 Electric Ballast Surface Mount Fixture	Office 1	50W 4' LED wide surface mounted wrap	RW3	1 fixture
ISB-VT-2	60W Incandescent Vanity	Bathroom	18W 2' LED vanity	V1	4 fixtures

Riverside Apartments

Incandescent ceiling surface mount fixtures were found in the office and main entry hallway. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the community room, kitchen, main entryway, mechanical room and offices. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Incandescent vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

There are (3) incandescent exit signs in the community room. It is recommended that these be replaced with LED exit signs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount Fixture	Office 1	14W 12" round LED fixture	RO2 (12")	2 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-2	60W Incandescent Surface Mount Fixture	Main entry hallway	22W 16" round LED fixture	RO3 (16")	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4' LED surface mounted wrap	RW1	14 fixtures
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Community room	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Kitchen	47W 4' LED surface mounted wrap	RW2	2 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Main entry hallway	47W 4' LED surface mounted wrap	RW2	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Mechanical room	47W 4' LED surface mounted wrap	RW2	7 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 1	47W 4' LED surface mounted wrap	RW2	3 fixtures
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Office 2	47W 4' LED surface mounted wrap	RW2	4 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 2	47W 4' LED surface mounted wrap	RW2	7 fixtures
ISB-VT-4	60W Incandescent Vanity	Bathroom	34W 4' LED vanity	V2	2 fixtures
ISB-EX-2	25W Incandescent Exit Sign	Community room	LED exit sign	X1	3 fixtures

Sahara Ramsey

A CFL ceiling surface mount fixture was found in the upstairs landing. It is recommended that it be replaced with a round LED ceiling fixture.

Linear fluorescent fixtures were found in the laundry room, corridors and upstairs landing. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures or LED recessed fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Upstairs landing 1	14W 12" round LED fixture	RO2 (12")	1 fixture
T12M4-RT-2	40W 4' T12 Magnetic Ballast Recessed Troffer	Laundry room	32W 1'x4' recessed LED fixture	RR2	4 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Downstairs corridor 1	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Downstairs corridor 2	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Downstairs corridor 1	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Upstairs landing 2	50W 4' LED wide surface mounted wrap	RW3	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Downstairs corridor 2	50W 4' LED wide surface mounted wrap	RW3	2 fixtures

South San

CFL and incandescent screw-in bulbs were found in the kitchen, attic, and laundry room. It is recommended that these be replaced with LED bulbs with similar bases.

CFL ceiling surface mount fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the storage areas, bathroom, electrical room, office, community room, and kitchen. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures or wrap fixtures.

CFL vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-Stove-1	40W Incandescent Stove Light	Kitchen	9.5W LED Bulb	L1	1 bulb
CSB-SM-1	13W Screw Base CFL Surface Mount Fixture	Attic	9.5W LED Bulb	L1	2 bulbs
ISB-FN-4	60W Incandescent Ceiling Fan	Laundry room	9.5W LED Bulb	L1	4 bulb
CSB-SM-2	13W Screw Base CFL Surface Mount Fixture	Bathroom	22W 16” round LED fixture	RO3 (16”)	2 fixtures
T12M2-SM-1	40W 2’ T12 Magnetic Ballast Surface Mount Fixture	Storage	22W 4’ LED surface mounted strip light	RS3	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Bathroom	36W 4’ LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Electrical room	36W 4’ LED surface mounted wrap	RW1	1 fixture
T8E4-SM-4	32W 4’ T8 Electric Ballast Surface Mount Fixture	Electrical room	36W 4’ LED surface mounted wrap	RW1	1 fixture
T8E4-SM-4	32W 4’ T8 Electric Ballast Surface Mount Fixture	Office 1	36W 4’ LED surface mounted wrap	RW1	2 fixtures
T8E4-SM-4	32W 4’ T8 Electric Ballast Surface Mount Fixture	Community room	50W 4’ LED wide surface mounted wrap	RW3	12 fixtures
T8E4-SM-4	32W 4’ T8 Electric Ballast Surface Mount Fixture	Kitchen	50W 4’ LED wide surface mounted wrap	RW3	2 fixtures
CSB-VT-4	13W Screw Base CFL Vanity	Bathroom	34W 4’ LED vanity	V2	2 fixtures

Sun Park Lane

CFL and incandescent screw-in bulbs were found in the bathroom and boiler room. It is recommended that these be replaced with LED bulbs with similar bases.

There are 2’ and 4’ T8 and T12 fixtures in the elevators. 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.

CFL ceiling surface mount fixtures were found in the storage shed and lobby. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the maintenance areas, vestibule, community room, kitchen, storage areas, laundry room, elevator room, corridor, and offices. It is recommended that all fixtures in these areas be replaced with appropriate LED strip fixtures or wrap fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-3	14W Screw Base CFL Surface Mount Fixture	Bathroom	9.5W LED Bulb	L1	6 bulbs
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Boiler room	9.5W LED Bulb	L1	1 bulb
ISB-SM-1	60W Incandescent Surface Mount Fixture	Boiler room	9.5W LED Bulb	L1	1 bulb
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Elevator	4’ Type C LED Tube with Remote Driver	RL6 (4’)	4 bulbs
T8E2-SM-2	17W 2’ T8 Electric Ballast Surface Mount Fixture	Elevator	4’ Type C LED Tube with Remote Driver	RL6 (4’)	2 bulbs
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	storage shed	14W 12” round LED fixture	RO2 (12”)	1 fixture
CSB-SM-2	14W Screw Base CFL Surface Mount Fixture	Lobby	22W 16” round LED fixture	RO3 (16”)	14 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Maintenance	32W 4’ LED surface mounted strip light	RS4	12 fixtures
T8E4-SM-2	32W 4’ T8 Electric Ballast Surface Mount Fixture	Main entry vestibule	36W 4’ LED surface mounted wrap	RW1	6 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4’ LED surface mounted wrap	RW1	22 fixtures
T12E4-SM-2	32W 4’ T12 Electric Ballast Surface Mount Fixture	Community room	36W 4’ LED surface mounted wrap	RW1	10 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Kitchen	36W 4’ LED surface mounted wrap	RW1	2 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Storage 1	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Storage 2	36W 4' LED surface mounted wrap	RW1	4 fixtures
T12E4-SM-2	32W 4' T12 Electric Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	6 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Elevator room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Corridor	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 1	50W 4' LED wide surface mounted wrap	RW3	4 fixtures
T12E4-SM-4	32W 4' T12 Electric Ballast Surface Mount Fixture	Office 2	50W 4' LED wide surface mounted wrap	RW3	2 fixtures

TL Shaley

CFL and incandescent screw-in and CFL 2-pin bulbs were found in the offices and kitchen. It is recommended that these be replaced with LED bulbs with similar bases.

CFL, halogen, and incandescent ceiling surface mount fixtures were found in the storage areas and maintenance building. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the lobby, community room, garage, laundry room, and maintenance building. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Office 2	9.5W LED Bulb	L1	3 bulbs
CSB-FN-3	23W Screw Base CFL Ceiling Fan	Office 2	9.5W LED Bulb	L1	3 bulb
ISB-Stove-1	40W Incandescent Stove Light	Kitchen	9.5W LED Bulb	L1	1 bulb

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C2P-SM-2	13W 2-Pin CFL Surface Mount Fixture	Office 1	8.5W LED 2 pin bulb	L5a	6 bulbs
ISB-FN-3	40W Incandescent Ceiling Fan	Office 1	7W LED candelabra bulb	L6	3 bulb
ISB-SM-1	60W Incandescent Surface Mount Fixture	Storage	14W 12” round LED fixture	RO2 (12”)	1 fixture
HSB-SM-1	40W Halogen Surface Mount Fixture	Maintenance room	14W 12” round LED fixture	RO2 (12”)	2 fixtures
HSB-SM-	40W Halogen Surface Mount Fixture	Maintenance building	14W 12” round LED fixture	RO2 (12”)	1 fixture
ISB-SM-1	60W Incandescent Surface Mount Fixture	Maintenance building	14W 12” round LED fixture	RO2 (12”)	1 fixture
ISB-SM-1	60W Incandescent Surface Mount Fixture	Maintenance building	14W 12” round LED fixture	RO2 (12”)	3 fixtures
HSB-SM-2	40W Halogen Surface Mount Fixture	Maintenance building	22W 16” round LED fixture	RO3 (16”)	9 fixtures
C2P-SM-2	13W 2-Pin CFL Surface Mount Fixture	Maintenance building	22W 16” round LED fixture	RO3 (16”)	1 fixture
ISB-SM-2	60W Incandescent Surface Mount Fixture	Maintenance building	22W 16” round LED fixture	RO3 (16”)	1 fixture
T12E4-SM-2	40W 4’ T12 Electric Ballast Surface Mount Fixture	Lobby	36W 4’ LED surface mounted wrap	RW1	3 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4’ LED surface mounted wrap	RW1	5 fixtures
T12E4-SM-2	40W 4’ T12 Electric Ballast Surface Mount Fixture	Community room	36W 4’ LED surface mounted wrap	RW1	5 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Garage	36W 4’ LED surface mounted wrap	RW1	3 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Maintenance building	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M2-SM-2	40W 2' T12 Magnetic Ballast Surface Mount Fixture	Maintenance building	36W 4' LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Maintenance building	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Maintenance building	47W 4' LED surface mounted wrap	RW2	1 fixture
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Laundry room	47W 4' LED surface mounted wrap	RW2	4 fixtures

Tarry Towne

A CFL ceiling surface mount fixture was found in the laundry room. It is recommended that it be replaced with a round LED ceiling fixture.

Linear fluorescent fixtures were found in the community room, office, bathroom, laundry room, and mechanical room. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures or recessed fixtures.

Incandescent vanity fixtures were found in the bathrooms. It is recommended that these fixtures be replaced with LED vanity fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-2	14W Screw Base CFL Surface Mount Fixture	Laundry room	22W 16" round LED fixture	RO3 (16")	1 fixture
T12M4-RC-4	40W 4' T12 Magnetic Ballast Recessed Fixture	Community room	49W 2'x4' recessed LED fixture	RR4	15 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Office 1	36W 4' LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Office 1	36W 4' LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Bathroom	36W 4' LED surface mounted wrap	RW1	2 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Mechanical room	36W 4' LED surface mounted wrap	RW1	9 fixtures
T12M8-SM-1	96W 8' T12 Magnetic Ballast Surface Mount Fixture	Mechanical room	2x 36W 2'x4' LED surface mounted wrap	RW1	2 fixtures
ISB-VT-2	60W Incandescent Vanity	Bathroom	18W 2' LED vanity	V1	2 fixtures

Villa Veramendi

CFL and incandescent ceiling surface mount fixtures were found in the storage areas, mechanical room, and bathroom. It is recommended that these fixtures be replaced with round LED ceiling fixtures.

Linear fluorescent fixtures were found in the storage areas, main entry vestibule, community room, corridor, office, and maintenance area. It is recommended that all fixtures in these areas be replaced with appropriate LED recessed fixtures.

There are (4) incandescent exit signs throughout the building. It is recommended that these be replaced with LED exit signs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C2P-SM-1	13W 2-Pin CFL Surface Mount Fixture	Storage	14W 12" round LED fixture	RO2 (12")	1 fixture
ISB-SM-1	60W Incandescent Surface Mount Fixture	Mechanical room	14W 12" round LED fixture	RO2 (12")	1 fixture
ISB-SM-2	60W Incandescent Surface Mount Fixture	Bathroom	22W 16" round LED fixture	RO3 (16")	3 fixtures
T12M4-RC-2	40W 4' T12 Magnetic Ballast Recessed Fixture	Storage	32W 1'x4' recessed LED fixture	RR2	8 fixtures
T12M4-RC-4	40W 4' T12 Magnetic Ballast Recessed Fixture	Main entry vestibule	49W 2'x4' recessed LED fixture	RR4	6 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M4-RC-4	40W 4' T12 Magnetic Ballast Recessed Fixture	Community room	49W 2'x4' recessed LED fixture	RR4	11 fixtures
T12M4-RC-4	40W 4' T12 Magnetic Ballast Recessed Fixture	Corridor	49W 2'x4' recessed LED fixture	RR4	3 fixtures
T12M4-RC-4	40W 4' T12 Magnetic Ballast Recessed Fixture	Storage	49W 2'x4' recessed LED fixture	RR4	2 fixtures
T12M4-RC-4	40W 4' T12 Magnetic Ballast Recessed Fixture	Office 1	49W 2'x4' recessed LED fixture	RR4	8 fixtures
T12M4-RC-4	40W 4' T12 Magnetic Ballast Recessed Fixture	Office 2	49W 2'x4' recessed LED fixture	RR4	8 fixtures
T12E4-SM-4	40W 4' T12 Electric Ballast Surface Mount Fixture	Maintenance	49W 2'x4' recessed LED fixture	RR4	11 fixtures
ISB-EX-2	15W Incandescent Exit Sign	Main entry vestibule	LED exit sign	X1	4 fixtures

Westway

Incandescent screw-in bulbs were found in the maintenance bathroom. It is recommended that these be replaced with LED bulbs with similar bases.

Linear fluorescent fixtures were found throughout the leasing office and maintenance office. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures and LED recessed fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-2	60W Incandescent Surface Mount Fixture	Maintenance – Bathroom	9.5W LED Bulb	L1	2 bulbs
T8E2U-SM-2	32W 2' T8 U-lamp Electric Ballast Surface Mount Fixture	Leasing – Office 1	32W 2'x2' surface LED fixture	RR6	2 fixtures
T8E2U-SM-2	32 W 2' T8 U-lamp Electric Ballast Surface Mount Fixture	Leasing – Corridor	32W 2'x2' surface LED fixture	RR6	4 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T12M28-SM-2	96W 8' T12 Magnetic Ballast Surface Mount Fixture	Maintenance – Office 2	57W 1'x8' LED surface mounted fixture	RS6	7 fixtures
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Leasing – Office Closet	36W 4' LED surface mounted wrap	RW1	1 fixture
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Bathroom	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Leasing – Kitchen	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Leasing – Mechanical room	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Leasing – Bathroom	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Leasing – Office 1	36W 4' LED surface mounted wrap	RW1	1 fixture
T12M4-SM-2	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Maintenance – Office 1	36W 4' LED surface mounted wrap	RW1	10 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Corridor	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Office 1	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Office 1	50W 4' LED wide surface mounted wrap	RW3	4 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Community room	50W 4' LED wide surface mounted wrap	RW3	21 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Kitchen	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Bathroom	50W 4' LED wide surface mounted wrap	RW3	2 fixtures

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Bathroom	50W 4' LED wide surface mounted wrap	RW3	2 fixtures
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount Fixture	Leasing – Office 1	50W 4' LED wide surface mounted wrap	RW3	5 fixtures

William Sinkin

Incandescent screw-in candelabra bulbs were found in the kitchen ceiling fans. It is recommended that these be replaced with LED bulbs with similar bases.

An incandescent ceiling surface mount fixture was found in the storage closet. It is recommended that it be replaced with a round LED ceiling fixture.

There is a T12 under cabinet fixture in the kitchen. It is recommended that it be replaced with an LED under cabinet fixture.

Linear fluorescent fixtures were found in the bathroom, laundry room, corridor, and office. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

There are CFL sconce fixtures in the corridor and sink closet, which is recommended to be replaced with LED wall sconce fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-FN-4	15W Incandescent Ceiling Fan	Kitchen	7W LED candelabra bulb	L6	8 bulbs
ISB-SM-1	60W Incandescent Surface Mount Fixture	Storage	14W 12" round LED fixture	RO2 (12")	1 fixture
T12M2-UC-1	15W 2' T12 Magnetic Ballast Under Cabinet Fixture	Kitchen	11W LED under cabinet	RS1b	1 fixture
T12M4-SM-1	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Bathroom	36W 4' LED surface mounted wrap	RW1	1 fixture
T12E4-SM-2	40W 4' T12 Electric Ballast Surface Mount Fixture	Laundry room	36W 4' LED surface mounted wrap	RW1	2 fixtures
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Corridor	47W 4' LED surface mounted wrap	RW2	1 fixture
T12M4-SM-4	40W 4' T12 Magnetic Ballast Surface Mount Fixture	Office 2	50W 4' LED wide surface mounted wrap	RW3	1 fixture

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SC-1	23W Screw Base CFL Sconce	Corridor and Sink Closet	10W LED wall sconce	WS1	4 fixtures

Williamsburg

A CFL screw-in bulb was found in the boiler room. It is recommended that it be replaced with a LED bulb with a similar base.

An incandescent ceiling surface mount fixture was found in the storage closet. It is recommended that it be replaced with a round LED ceiling fixture.

Linear fluorescent fixtures were found in the community room and laundry room. It is recommended that all fixtures in these areas be replaced with appropriate LED wrap fixtures.

An incandescent vanity fixture was found in the bathroom. It is recommended that this fixture be replaced with an LED vanity fixture.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-1	14W Screw Base CFL Surface Mount Fixture	Boiler	9.5W LED Bulb	L1	1 bulb
ISB-SM-1	60W Incandescent Surface Mount Fixture	Storage	14W 12” round LED fixture	RO2 (12”)	1 fixture
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Community room	36W 4’ LED surface mounted wrap	RW1	4 fixtures
T12M4-SM-2	40W 4’ T12 Magnetic Ballast Surface Mount Fixture	Laundry room	36W 4’ LED surface mounted wrap	RW1	1 fixture
ISB-VT-2	40W Incandescent Vanity	Bathroom	18W 2’ LED vanity	V1	1 fixture

Improvements to Operations and Maintenance:

The equipment life of the new lighting fixtures is expected to be 10 years, which will reduce maintenance costs since they will not need to be replaced as often. No repairs are required for this measure to be effective. No new skills are required.

Impacts to Residents:

This measure will not impact occupant health. The lighting levels will not be lowered, but could be improved by the new lighting, which would improve occupant comfort and safety.

Pricing and Site-Specific Installation Notes to Contractor:

Basis of design products are provided in the related specifications. Please provide as a separate line item an allowance for the full fixture replacement of an additional 10% of listed retrofit counts. The positioning

of new lighting should be cleared with SAHA prior to installation. Any concerns with retrofit mounting location, matching existing lighting distribution, or meeting electrical requirements should be coordinated with SAHA prior to install or purchase of fixtures.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									
		Water & Sewer			Electricity			Natural Gas			Total Energy Savings
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Villa Veramendi	HE Lighting - Common	-	-	-	22,151	$ 0.12380	$ 2,742	-	-	-	$ 2,742
Sun Park Lane	HE Lighting - Common	-	-	-	17,250	$ 0.10270	$ 1,772	-	-	-	$ 1,772
Frank Hornsby	HE Lighting - Common	-	-	-	21,727	$ 0.10270	$ 2,231	-	-	-	$ 2,231
Mission Park	HE Lighting - Common	-	-	-	20,891	$ 0.11540	$ 2,411	-	-	-	$ 2,411
Tarry Towne	HE Lighting - Common	-	-	-	9,356	$ 0.10080	$ 943	-	-	-	$ 943
Escondida	HE Lighting - Common	-	-	-	3,202	$ 0.10080	$ 323	-	-	-	$ 323
Williamsburg	HE Lighting - Common	-	-	-	1,374	$ 0.10080	$ 138	-	-	-	$ 5,460
Matt Garcia	HE Lighting - Common	-	-	-	7,882	$ 0.08870	$ 699	-	-	-	$ 699
Blanco	HE Lighting - Common	-	-	-	47,164	$ 0.09560	$ 4,509	-	-	-	$ 4,509
Lewis Chatham	HE Lighting - Common	-	-	-	130,133	$ 0.09080	$ 11,816	-	-	-	$ 11,816
Linda Lou	HE Lighting - Common	-	-	-	214	$ 0.12400	$ 27	-	-	-	$ 27
Riverside Apts	HE Lighting - Common	-	-	-	10,333	$ 0.12400	$ 1,281	-	-	-	$ 1,281
Linda Lou	HE Lighting - Common	-	-	-	321	$ 0.12400	$ 40	-	-	-	$ 40
Midway	HE Lighting - Common	-	-	-	4,828	$ 0.12400	$ 599	-	-	-	$ 599
Madonna	HE Lighting - Common	-	-	-	537	$ 0.10580	$ 57	-	-	-	$ 57
Sahara Ramsey	HE Lighting - Common	-	-	-	7,508	$ 0.10580	$ 794	-	-	-	$ 794
Cheryl West	HE Lighting - Common	-	-	-	6,084	$ 0.22910	$ 1,394	-	-	-	$ 1,394
T. L. Shaley	HE Lighting - Common	-	-	-	7,292	$ 0.22910	$ 1,671	-	-	-	$ 1,671
Jewett Circle	HE Lighting - Common	-	-	-	23,827	$ 0.10460	$ 2,492	-	-	-	$ 2,492
Col. Cisneros	HE Lighting - Common	-	-	-	4,461	$ 0.10460	$ 467	-	-	-	$ 467
Highview Apts	HE Lighting - Common	-	-	-	8,251	$ 0.09660	$ 797	-	-	-	$ 797
William Sinkin	HE Lighting - Common	-	-	-	2,113	$ 0.09660	$ 204	-	-	-	$ 204
Cross Creek	HE Lighting - Common	-	-	-	5,058	$ 0.15410	$ 779	-	-	-	$ 779
Morris C. Beldon	HE Lighting - Common	-	-	-	5,673	$ 0.15410	$ 874	-	-	-	$ 874
L.C. Rutledge	HE Lighting - Common	-	-	-	9,251	$ 0.15410	$ 1,426	-	-	-	$ 1,426
Westway	HE Lighting - Common	-	-	-	15,878	$ 0.15420	$ 2,448	-	-	-	$ 2,448
H.B. Gonzalez	HE Lighting - Common	-	-	-	13,968	$ 0.15420	$ 2,154	-	-	-	$ 2,154
Pin Oak II	HE Lighting - Common	-	-	-	5,979	$ 0.14370	$ 859	-	-	-	$ 859
Lila Cockrell	HE Lighting - Common	-	-	-	10,568	$ 0.12170	$ 1,286	-	-	-	$ 1,286
South San	HE Lighting - Common	-	-	-	5,457	$ 0.12170	$ 664	-	-	-	$ 664
Raymundo Rangel	HE Lighting - Common	-	-	-	3,311	$ 0.11820	$ 391	-	-	-	$ 391
Mirasol Homes	HE Lighting - Common	-	-	-	21,051	$ 0.11820	$ 2,488	-	-	-	$ 2,488
Christ the King	HE Lighting - Common	-	-	-	7,130	$ 0.11820	$ 843	-	-	-	$ 843
Pin Oak I	HE Lighting - Common	-	-	-	20,636	$ 0.10080	$ 2,080	-	-	-	$ 2,080

Calculation Methodology:

The savings is evaluated by multiplying the change in lighting load by the typical runtime hours as shown.

$$kWh\ Savings = (Existing\ Load - New\ Load) \times Hrs \times Nbr\ Lamps \times \frac{kW}{1000W}$$

Existing Load = Wattage of Existing Lamp/Fixture

New Load = Wattage of New Lamp/Fixture

Hrs – Annual hours of operation by space time

Nbr Lamps – Number of lamps/fixtures to be replaced

All savings calculation details can be found within the “SAHA Phase II Savings Calculator” excel spreadsheet that has been provided as a supplement to this report.

5.2.3 Exterior Lighting Retrofit – ECM 2-230

Exterior lighting efficiency opportunities were found at the following sites.

Blanco

There is (1) 54W 4' T5 Magnetic Ballast Flag Light, (1) 100W Mercury Vapor Flag Light, and (12) 65W Incandescent Flag Lights. It is recommended that these be replaced with 51W LED spotlights.

There are also (4) 23W screw-in CFL bulbs in the canopy. It is recommended that these be replaced with 16.5W LED screw-in bulbs.

There are (3) 23W CFL sconce fixtures in the walkway by the garden and (1) 23W CFL sconce fixture outside of the maintenance door, which are recommended to be replaced with 25W LED mini wall packs.

There are (8) 150W metal halide pole heads in the parking lot, which are recommended to be replaced with 96W LED pole light heads.

There are (4) 100W sodium vapor wall packs around the building exterior. It is recommended that these be replaced with 28W LED wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T5M4-FG-1	54W 4' T5 Magnetic Ballast Flag Light	Signage	51W LED ground mount sign light	WL1	1 fixture
MV-FG-1	100W Mercury Vapor Flag Light	Flag pole	51W LED ground mount flag light	WL1	1 fixture
CSB-CN-1	23W Screw Base CFL Can Light	Canopy	16.5W LED Bulb	L2	4 bulbs
ISB-FG-1	65W Incandescent Flag Light	tree boxes	51W LED flag light	WL1	12 fixtures
CSB-SC-1	23W Screw Base CFL Sconce	walkway by garden	25W LED mini wall pack	WP4	3 fixtures
CSB-SC-1	23W Screw Base CFL Sconce	Outside maintenance door	25W LED mini wall pack	WP4	1 fixture
MSB-PL-1	150W Metal Halide Pole Light	Parking lot	96W LED parking lot pole light head(s)	P1-b	8 pole light heads
SSB-WP-1	100W Sodium Vapor Wall Pack	Walls	28W LED wall pack	WP2b	4 fixtures

Cheryl West

There are (14) 150W metal halide wall packs around the building exteriors. It is recommended that these be replaced with 28W LED wall packs.

There are also some screw-in incandescent bulbs. It is recommended that these be replaced with 10.5W LED screw-in bulbs.

There are (2) dual head flood lights, which is recommended to be replaced with dual head motion sensing LED flood lights.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-WP-1	150W Metal Halide Wall Pack	Exterior Walls	28W LED wall pack	WP2b	14 fixtures
ISB-SM-1	60W Incandescent Surface Mount	Exterior	10.2W LED Bulb	L7	3 bulbs
ISB-FD-2	90W Incandescent Flood Light	Exterior	31W Dual-head LED flood light with motion sensing control	FL2	4 fixtures

Christ the King

There are (10) 50W halogen can lights in the canopy, which are recommended to be replaced with 10.2W LED bulbs.

There are (11) 2-Pin CFL sconce fixtures which are recommended to be replaced with 25W LED mini wall packs.

There are (17) 100W metal halide pole lights along the perimeter. It is recommended that these pole heads be replaced with 52W LED pole light heads.

CFL 2-pin can lights were found in exterior corridor of East stacked building. It is recommended that these be replaced with LED bulbs with similar bases.

There are (24) 100W metal halide wall packs on the West side of the stacked building and (1) 150W sodium vapor wall pack around perimeter of stacked building. It is recommended that these be replaced with 28W LED wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
HSB-CN-1	50W Halogen Can Light	Canopy	10.2W LED Bulb	L7	10 bulbs
C2P-SC-1	28W 2-Pin CFL Sconce	Around community	25W LED mini wall pack	WP4	11 fixtures
MSB-pl-1	100W Metal Halide Pole Light	Perimeter	52W LED walkway pole light head	P1-a	17 pole light heads
C2P-CN-2	13W 2-Pin CFL Can Light	Exterior corridor of East stacked building	8.5W LED 2 pin bulb	L5a	144 bulbs
MSB-WP-1	100W Metal Halide Wall Pack	W side stacked building	28W LED wall pack	WP2b	24 fixtures
SSB-WP-1	150W Sodium Vapor Wall Pack	Front + back of rowhomes, around	28W LED wall pack	WP2b	1 fixture

		perimeter of stacked building			

Col. Cisneros

There are (34) CFL sconce fixtures along the walkways and (11) around the community building, which are recommended to be replaced with 9W LED mini wall packs.

There are (5) 150W sodium vapor wall packs and (1) 150W metal halide wall pack for security lighting around the site. It is recommended that these be replaced with 28W LED wall packs.

There are (2) 400W metal halide pole lights on the site boundary and (2) dual-head 400W metal halide pole heads in the parking lot, which are recommended to be replaced with 166W LED pole light heads (for a total of 6 pole light heads).

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C4P-SC-1	13W 4-Pin CFL Sconce	Walkways	9W LED wall pack	WP7	34 fixtures
SSB-WP-1	150W Sodium Vapor Wall Pack	Security around site	28W LED wall pack	WP2b	5 fixtures
MSB-WP-	150W Metal Halide Wall Pack	Security around site	28W LED wall pack	WP2b	1 fixture
C4P-SC-1	13W 4-Pin CFL Sconce	Around community building	9W LED wall pack	WP7	11 fixtures
MSB-PL-1	400W Metal Halide Pole Light	Site boundary	166W LED parking lot pole light head(s)	P1-c	2 pole light heads
MSB-PL-2	400W Metal Halide Dual Head Pole Light	Parking lot	2x 166W LED parking lot pole light heads	P2-c	4 pole light heads (2 poles)

Cross Creek

There are (2) 23W surface mount screw-in CFL bulbs in the community building entry. It is recommended that these be replaced with 16.5W LED screw-in bulbs.

There are (2) 150W metal halide pole lights outside of the community building. It is recommended that these pole heads be replaced with 52W LED walkway pole light heads.

There are (26) 150W metal halide wall packs around the building exterior. It is recommended that these be replaced with 28W LED wall packs.

There are (8) 150W metal halide sconces around the building exterior. It is recommended that these be replaced with 24W dual-headed LED flood lights.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-1	23W Screw Base CFL Surface Mount	Community building entry	16.5W LED Bulb	L2	2 bulbs
MSB-PL-1	150W Metal Halide Pole Light	Community building	52W LED walkway pole light head	P1-a	1 pole light head
MSB-PL-1	150W Metal Halide Pole Light	Community building	52W LED walkway pole light head	P1-a	1 pole light head
MSB-WP-1	150W Metal Halide Wall Pack	Building walls	28W LED wall pack	WP2b	26 fixtures
MSB-SC-1	150W Metal Halide Sconce	Building walls	24W Dual-head LED flood light	FL3	8 fixtures

Escondida

There are (5) dual head flood lights, which are recommended to be replaced with a dual head motion sensing LED flood lights.

There are (29) 14W surface mount screw-in CFL bulbs along the walkways and (3) in the car port. It is recommended that the (29) walkways bulbs be replaced with 9W LED screw-in bulbs and the (3) car port bulbs be replaced with a 10W LED jelly jar.

There are also a number of 60W screw-in incandescent bollards and sconces. It is recommended that these be replaced with 10.2W LED screw-in bulbs.

There are (8) 100W sodium vapor wall packs on the south side of the building. It is recommended that these be replaced with 28W LED wall packs.

The (4) square ceiling mount fixtures in the car port should be replaced with 17W LED ceiling fixtures.

The car port also has a 4’ T12 ceiling fixture. It is recommended that this be replaced with a 22W 4’ LED strip fixture.

There are (20) screw-in CFL/incandescent decorative wall sconces in the entryway of each unit. It is recommended that these be replaced with LED wall sconces.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-FD-2	23W Screw Base CFL Flood Light	Building exterior corner	31W Dual-head LED flood light with motion sensing control	FL2	5 fixtures
CSB-SM-1	14W Screw Base CFL Surface Mount	Walkways	9W LED decorative ceiling fixture	LC4	29 fixtures
CSB-SM-1	14W Screw Base CFL Surface Mount	Car port	10W LED Jelly Jar	WP6	3 fixtures

ISB-BD-1	60W Incandescent Bollard	Posts	10.2W LED Bulb	L7	6 bulbs
CSB/ISB-SC-2	Screw Base CFL/Incandescent Sconce	Main and side entry	10.2W LED Bulb	L7	8 bulbs
SSB-WP-1	100W Sodium Vapor Wall Pack	South side	28W LED wall pack	WP2b	8 fixtures
SM-1	Square Ceiling Mount Fixtures	Car port 2	17W LED ceiling fixture	LC2	4 fixtures
T12M4-SM-1	40W 4' T12 Magnetic Ballast Surface Mount	Car port 2	22W 4' LED surface mounted strip light	RS3	1 fixture
CSB/ISB-SC-1	Screw Base CFL/Incandescent Sconce	Entryway per unit	9W LED wall sconce	WP5	20 fixtures

Frank Hornsby

There are (3) 150W sodium vapor flag spotlights and (1) 70W metal halide flag spotlight. It is recommended that these be replaced with 51W LED spotlights.

CFL 2-pin bulbs were found in office main entry. It is recommended that these be replaced with LED bulbs with similar bases.

There are (21) 150W halogen wall packs around the building exterior. It is recommended that these be replaced with 28W LED wall packs.

There are (2) 400W metal halide pole lights and (4) dual-head 400W metal halide pole lights in the parking lot, which are recommended to be replaced with 166W LED pole light heads (for a total of 10 pole light heads).

There are (8) 23W screw-in CFL sconces in the entryways. It is recommended that these be replaced with 16.5W LED screw-in bulbs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
SSB-FG-1	150W Sodium Vapor Flag Light	Building sign and flags	51W LED flag light	WL1	3 fixtures
MSB-FG-1	70W Metal Halide Flag Light	Building sign and flags	51W LED flag light	WL1	1 fixture
C2P-PN-2	13W 2-Pin CFL Pendant	Office main entry	8.5W LED 2 pin bulb	L5a	16 bulbs
SSB-WP-1	150W Halogen Wall Pack	Building exterior	28W LED wall pack	WP2b	21 fixtures

MSB-PL-2	400W Metal Halide Pole Light	Parking lot	2x 166W LED parking lot pole light heads	P2-c	8 pole light heads (4 poles)
MSB-PL-1	400W Metal Halide Pole Light	Parking lot	166W LED parking lot pole light head(s)	P1-c	2 pole light heads
CSB-SC-1	23W Screw Base CFL Sconce	Entryways	16.5W LED Bulb	L2	8 bulbs

HB Gonzalez

There are (4) 250W sodium vapor pole lights and (2) dual-head 250W sodium vapor pole lights in the parking lot, which are recommended to be replaced with 166W LED pole light heads (for a total of 8 pole light heads).

In the entry canopy there are (6) 65W screw-in incandescent flood lights. It is recommended that these be replaced with 10.2W LED screw-in bulbs.

There are (5) 100W new sodium vapor wall packs (6) 100W old sodium vapor wall packs around the building exterior. It is recommended that these be replaced with 28W LED wall packs.

The (21) 60-100W incandescent decorative wall sconces in the walkways and (2) in the entryway are recommended to be replaced with 9W LED wall sconces.

There are (5) 100W surface mount screw-in incandescent bulbs in the courtyard canopy and (8) in the stairwells. It is recommended that these are replaced with 17W LED ceiling fixtures.

In the maintenance building, there are (2) 100W sodium vapor flood lights, which are recommended to be replaced with motion sensing LED flood lights.

There is also (1) 13W 4-pin CFL wall sconce in the maintenance building. It is recommended that this is replaced with an LED wall sconce.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
SSB-PL-2	250W Sodium Vapor Dual-Headed Pole Light	Parking	2x 166W LED parking lot pole light heads	P2-c	4 pole light heads (2 poles)
SSB-PL-1	250W Sodium Vapor Pole Light	parking median	166W LED parking lot pole light head(s)	P1-c	4 pole light heads
ISB-FD-1	65W Incandescent Flood Light	entry canopy	10.2W LED Bulb	L7	6 bulbs
SSB-WP-1	100W Sodium Vapor Wall Pack	New	28W LED wall pack	WP2b	5 fixtures
SSB-WP-1	100W Sodium Vapor Wall Pack	Old	28W LED wall pack	WP2b	6 fixtures
ISB-SC-1	100W Incandescent Sconce	Walkways	9W LED wall sconce	WP5	5 fixtures

ISB-SC-1	100/60W Incandescent Sconce	Walkways	9W LED wall sconce	WP5	15 fixtures
ISB-SM-1	60W Incandescent Surface Mount	Stairwells	17W LED ceiling fixture	LC2	8 fixtures
ISB-SM-1	60W Incandescent Surface Mount	courtyard canopy	17W LED ceiling fixture	LC2	5 fixtures
ISB-SC-1	100W Incandescent Sconce	entryway	9W LED wall sconce	WP5	2 fixtures
SSB-FD-1	100W Sodium Vapor Flood Light	Maintenance building	21W LED flood light with motion sensing control	FL1	2 fixtures
C4P-SC-1	13W 4-Pin CFL Sconce	Maintenance building	9W LED wall sconce	WP5	1 fixture

Highview

There are (3) 14W CFL decorative wall sconces on the community entry. It is recommended that these be replaced with LED wall sconces.

There are (39) 250W metal halide wall packs around the building exterior. It is recommended that these be replaced with 62W LED wall packs. There is also (1) 175W metal halide wall pack recommended to be replaced with a 28W LED wall pack.

There are (8) 400W metal halide pole lights around the site, (1) more south of the site, and (1) east of the site. These are recommended to be replaced with 166W LED pole light heads.

The (2) CFL sconce fixtures on the building exterior are recommended to be replaced with 9W LED mini wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SC-1	14W Screw Base CFL Sconce	community entry	9W LED wall sconce	WP5	3 fixtures
MSB-WP-1	250W Metal Halide Wall Pack	Building exterior	62W LED wall pack	WP3b	39 fixtures
MV-WP-1	175W Mercury Vapor Wall Pack	Building exterior	28W LED wall pack	WP2b	1 fixture
MSB-PL-1	400W Metal Halide Pole Light	Around site	166W LED parking lot pole light head(s)	P1-c	8 pole light heads
MSB-PL-1	400W Metal Halide Pole Light	South of site	166W LED parking lot pole light head(s)	P1-c	1 pole light head
MSB-PL-1	400W Metal Halide Pole Light	East of site	166W LED parking lot pole light head(s)	P1-c	1 pole light head

CSB-SC-1	14W Screw Base CFL Sconce	Building exterior	9W LED wall pack	WP7	2 fixtures

Jewett Circle

There are (2) 150W metal halide wall packs on the maintenance building. It is recommended that these be replaced with 28W LED wall packs. There are also (4) 250W mercury vapor wall packs around the building exterior. It is recommended that these be replaced with 62W LED wall packs.

There are (4) 250W mercury vapor pole lights in the parking lot, which are recommended to be replaced with 166W LED pole light heads. There also (2) building-mounted gooseneck fixtures. It is recommended that these be relamped with 54W LED bulbs with similar bases.

CFL 2-pin bulbs were found in the exterior corridors and unit entries. It is recommended that these be replaced with LED bulbs with similar bases. There are also a number of screw-in incandescent bulbs in unit entries and canopy fixtures. It is recommended that these be replaced with 10.5W LED screw-in bulbs.

There is (1) 300W halogen flood light, which is recommended to be replaced with a 62W LED flood light.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C2P-SC-1	13W 2-pin CFL Bulb (in sconce)	Unit Entries (Corridor)	8.5W LED 2 pin bulb	L5a	48 bulbs
C2P-SC-2	13W 2-pin CFL Bulb (in sconce)	Corridor (Ext)	8.5W LED 2 pin bulb	L5a	24 bulbs
HFX-FD-1	300W halogen flood light	Maintenance Building	62W LED flood light	FL4	1 fixture
ISB-SC-1	60W Incandescent Bulb (in sconce)	Unit Entries (Corridor)	10.2W LED Bulb	L7	13 bulbs
ISB-CP-1	60W Incandescent Bulb (in canopy fixture)	Driveway	10.2W LED Bulb	L7	3 bulbs
MSB-WP-1A	150W metal halide wall pack	Maintenance Building	28W LED wall pack	WP2b	2 fixtures
MSB-PL-1A	250W mercury vapor pole light	Parking Lot	166W LED parking lot pole light head(s)	P1-c	4 pole light heads
MSB-PL-1C	250W mercury vapor pole light	Building Exterior	54W Screw-in LED bulb	L10c	2 bulbs
MSB-WP-1B	250W mercury vapor wall pack	Building Exterior	62W LED wall pack	WP3b	4 fixtures

LC Rutledge

There are (3) 14W screw-in CFL decorative wall sconces on the community building. It is recommended that these be replaced with LED wall sconces.

There are (6) 150W metal halide pole lights in the entry circles. It is recommended that these pole heads be replaced with 52W LED pole light heads.

There are (2) 14W surface mount screw-in CFL bulbs at the mailboxes. It is recommended that these are replaced with 11W LED ceiling fixtures.

There are (24) 150W metal halide wall packs scattered through the building exterior and (2) 150W metal halide wall packs on the community building. It is recommended that these be replaced with 28W LED wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SC-1	14W Screw Base CFL Sconce	Community building	9W LED wall sconce	WP5	3 fixtures
MSB-PL-1	150W Metal Halide Pole Light	Entry circles	52W LED walkway pole light head	P1-a	6 pole light heads
CSB-SM-1	14W Screw Base CFL Surface Mount	Mailboxes	11W LED ceiling fixture	LC3	2 fixtures
MSB-WP-1	150W Metal Halide Wall Pack	Scattered	28W LED wall pack	WP2b	24 fixtures
MSB-WP-1	150W Metal Halide Wall Pack	Community building	28W LED wall pack	WP2b	2 fixtures

Lewis Chatham

The entryway has (3) 4’ linear fluorescent fixtures. It is recommended that these fixtures be replaced with 32W 4’ LED strip fixtures.

There are (2) 150W metal halide walkway pole lights in the garden. It is recommended that these pole heads be replaced with 52W LED pole light heads.

There are (14) 250W metal halide pole lights in the parking lot, which are recommended to be replaced with 166W LED pole light heads.

There is also a screw-in CFL in a jelly jar outside the mechanical room entry. It is recommended that this be replaced with a 10W LED jelly jar.

There are (3) 150W metal halide wall at exterior entries. It is recommended that these be replaced with 28W LED wall packs.

The (27) 26W 2-pin CFL quarter sphere fixtures around the stairs and entries are recommended to be replaced with 20W LED quarter sphere wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-SM-2	4’ 2 Bulb T8 Surface Fixture	Entry	32W 4’ LED surface mounted strip light	RS4	3 fixtures

MSB-PL-1A	250W Metal Halide Pole Light	Parking Lot	166W LED parking lot pole light head(s)	P1-c	14 pole light heads
MSB-WP-1	150W Metal Halide Wall Pack	Exterior Entries	28W LED wall pack	WP2b	3 fixtures
MSB-PL-1B	150W Metal Halide Pole Light	Garden	52W LED walkway pole light head	P1-a	2 pole light heads
C2P-SC-1	26W 2-Pin CFL Sconce	Stairs and Entries	20W LED quarter sphere wall pack	WP8	27 fixtures
CSB-SC-1	18W Screw Base CFL Sconce	Mech Entry	10W LED Jelly Jar	WP6	1 fixture

Lila Cockerell

In the front entry canopy, there is a T8 fixture with 4' lamps stacked end-to-end. It is recommended that this be replaced with a 57W 8' LED fixture.

The entry canopy also has (4) 23W CFL can lights. It is recommended that these be relamped with LED bulbs.

There are (4) 2-Pin CFL decorative wall sconces at the front entry and (1) 2-pin CFL wall sconce along the east wall. It is recommended that these be replaced with LED wall sconces.

There is (1) 75W incandescent flag spotlight. It is recommended that this is replaced with 51W LED spotlight.

There are (2) 175W metal halide wall packs around the building exterior. It is recommended that these be replaced with 28W LED wall packs.

There are (4) 65W 4-pin CFL floods lights which are recommended to be replaced with dual head motion sensing LED flood lights.

There are (9) 175W metal halide pole lights in the courtyard. It is recommended that these pole heads be replaced with 52W LED pole light heads.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-SM-4	32W 4' T8 Electric Ballast Surface Mount	Front entry canopy	57W 1'x8' LED surface mounted fixture	RS6	1 fixture
CSB-CN-1	23W Screw Base CFL Can Light	Front entry canopy	16.5W LED Bulb	L2	4 bulbs
C2P-SC-1	13W 2-Pin CFL Sconce	Front entry	9W LED wall sconce	WP5	4 fixtures
ISB-FG-2	75W Incandescent Flag Light	Flag	51W LED flag light	WL1	1 fixture

MSB-WP-1	175W Metal Halide Wall Pack	Building Exterior	28W LED wall pack	WP2b	2 fixtures
C2P-SC-1	13W 2-Pin CFL Sconce	East wall	9W LED wall sconce	WP5	1 fixture
C4P-FD-1	65W 4-Pin CFL Flood Light	Building Exterior	31W Dual-head LED flood light with motion sensing control	FL2	7 fixtures
MSB-PL-1	175W Metal Halide Pole Light	Courtyard	52W LED walkway pole light head	P1-a	9 pole light heads

Linda Lou

There are (5) 65W 4-pin CFL wall packs which are recommended to be replaced with dual head motion sensing LED flood lights.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C4P-WP-1	65W 4-Pin CFL Wall Pack	Building exterior	31W Dual-head LED flood light with motion sensing control	FL2	5 fixtures

Madonna

There are (18) 175W halogen wall packs at the ends of the building. It is recommended that these be replaced with 28W LED wall packs.

There are (4) 23W screw-in CFL bollards throughout the landscaping and (8) pendants along the stairs. It is recommended that these be replaced with 16.5W LED screw-in bulbs.

Also in the landscaping are (8) 150W metal halide pole lights. It is recommended that these pole heads be replaced with 52W LED pole light heads.

The carports have (19) 23W surface mount canopy screw-in CFL bulbs. It is recommended that these are replaced with 17W LED ceiling fixtures.

The flag is illuminated with (1) 65W incandescent flag spotlight and is recommended to be replaced with a 51W LED spotlight. (1) dual-head flood light is located at Building 5, which is recommended to be replaced with a dual head motion sensing LED flood light.

There are (6) 150W metal halide pole lights in the courtyard. It is recommended that these pole heads be replaced with 52W LED pole light heads.

There are (2) 23W screw-in CFL decorative wall sconces on the community building. It is recommended that these be replaced with LED wall sconces.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
HSB-WP-1	175W Halogen Wall Pack	Building ends	28W LED wall pack	WP2b	18 fixtures

CSB-BD-1	23W Screw Base CFL Bollard	Landscaping	16.5W LED Bulb	L2	4 bulbs
MSB-PL-1	150W Metal Halide Pole Light	Landscaping	52W LED walkway pole light head	P1-a	8 pole light heads
CSB-Pendant-1	23W Screw Base CFL Pendant	Stairs	16.5W LED Bulb	L2	8 bulbs
CSB-SM-1	23W Screw Base CFL Surface Mount Canopy	Carports	17W LED ceiling fixture	LC2	19 fixtures
ISB-FG-1	65W Incandescent Flag Light	Flag	51W LED flag light	WL1	1 fixture
ISB-FD-2	65W Incandescent Dual-headed Flood Light	Building 5	31W Dual-head LED flood light with motion sensing control	FL2	1 fixture
MSB-PL-1	150W Metal Halide Pole Light	Courtyard	52W LED walkway pole light head	P1-a	6 pole light heads
CSB-SC-1	23W Screw Base CFL Sconce	Community	9W LED wall sconce	WP5	2 fixtures

Matt Garcia

There is (1) 4' T8 fixture mounted above the main entry. It is recommended that this be replaced with a 4' LED wrap fixture.

Throughout the building exterior, there are (8) 175W metal halide wall packs. It is recommended that these be replaced with 28W LED wall packs.

It is recommended that the (1) 60W incandescent sconce on the east wall be replaced with a 9W LED wall pack.

There are (12) 100W incandescent pole lights throughout the landscaping. It is recommended that these be replaced with 16.5W LED screw-in bulbs.

There are (3) 150W metal halide floods lights and (1) 75W incandescent flood light throughout the exterior, which are recommended to be replaced with dual head motion sensing LED flood lights.

The (1) 75W flag spotlight is recommended to be replaced with a 51W LED flag light.

There are (12) 14W screw-in CFL decorative wall sconces in the stairwells and (47) in the walkways. It is recommended that these be replaced with LED wall sconces. The walkways have (14) 14W screw-in CFL surface mount fixtures. It is recommended that these be replaced with 9W LED decorative ceiling fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8E4-SM-2	32W 4' T8 Electric Ballast Surface Mount	Main Entry	36W 4' LED surface mounted wrap	RW1	1 fixture

MSB-WP-1	150W Metal Halide Wall Pack	Building Exterior	28W LED wall pack	WP2b	8 fixtures
ISB-SC-1	60W Incandescent Sconce	East wall	9W LED wall pack	WP7	1 fixture
ISB-PL-1	100W Incandescent Pole Light	Landscaping	16.5W LED Bulb	L2	12 bulbs
MSB-FD-1	175W Metal Halide Flood Light	Building Exterior	31W Dual-head LED flood light with motion sensing control	FL2	3 fixtures
ISB-FD-2	75W Incandescent Flood Light	Building Exterior	31W Dual-head LED flood light with motion sensing control	FL2	1 fixture
ISB-FG-1	75W Incandescent Flag Light	Flag	51W LED flag light	WL1	1 fixture
CSB-SC-1	14W Screw Base CFL Sconce	Stairwells	9W LED wall sconce	WP5	12 fixtures
CSB-SM-1	14W Screw Base CFL Surface Mount	Walkways	9W LED decorative ceiling fixture	LC4	14 fixtures
CSB-SC-1	14W Screw Base CFL Sconce	Walkways	9W LED wall sconce	WP5	47 fixtures

Midway

There is a screw-in 60W incandescent in a jelly jar outside the backdoor of the community room. It is recommended that this be replaced with a 10W LED jelly jar.

The entry has (1) 100W sodium vapor wall pack. It is recommended that this be replaced with a 28W LED wall pack.

There are (7) 65W 4-pin CFL wall packs on the building exterior, which are recommended to be replaced with dual head motion sensing LED flood lights.

The walkways have ceiling fixtures which are a mix of LEDs and 14W screw-in CFLs. It is recommended that the (11) CFL fixtures be replaced with 9W LED decorative ceiling fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SM-1	60W Incandescent Surface Mount	back door community room	10W LED Jelly Jar	WP6	1 fixture
SSB-WP-1	100W Sodium Vapor Wall Pack	Entry	28W LED wall pack	WP2b	1 fixture
C4P-WP-1	65W 4-Pin CFL Wall Pack	Building exterior	31W Dual-head LED flood light with motion sensing control	FL2	7 fixtures

CSB-SM-1	14W Screw Base CFL Surface Mount	Walkways	9W LED decorative ceiling fixture	LC4	11 fixtures

Mirasol

In the townhome laundry, there is (1) 2-Pin CFL sconce fixture which is recommended to be replaced with a 25W LED mini wall pack.

There are (13) 65W 4-pin CFL flood lights on the community and residential buildings, which are recommended to be replaced with motion sensing LED flood lights.

There are (6) 400W metal halide pole lights in the townhome parking areas and (7) in the community parking lot, which are recommended to be replaced with 166W LED pole light heads.

There is (1) 150W sodium vapor wall pack near the townhome parking. It is recommended that this be replaced with a 28W LED wall pack.

There are also a few screw-in incandescent bulbs in the community building canopy fixtures. It is recommended that these be replaced with 10.2W LED screw-in bulbs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C2P-SC-2	13W 2-Pin CFL Sconce	Townhome Laundry	25W LED mini wall pack	WP4	1 fixture
C4P-FD-1	65W 4-Pin CFL Flood Light	Community Building	31W Dual-head LED flood light with motion sensing control	FL2	13 fixtures
MSB-PL-1	400W Metal Halide Pole Light	Townhome Parking	166W LED parking lot pole light head(s)	P1-c	6 pole light heads
MSB-PL-1	400W Metal Halide Pole Light	Community Parking	166W LED parking lot pole light head(s)	P1-c	7 pole light heads
SSB-WP-1	150W Sodium Vapor Wall Pack	Townhome Parking	28W LED wall pack	WP2b	1 fixture
ISB-CP-1	60W Incandescent Canopy Fixture	Community Building	10.2W LED Bulb	L7	3 bulbs

Mission Park

There are (2) 65W 4-pin CFL flood lights at the building gables, which are recommended to be replaced with motion sensing LED flood lights.

There are also (7) 175W metal halide wall packs at the building gables. It is recommended that these be replaced with 28W LED wall packs.

There are (36) 200W sodium vapor wall packs at the building gables. It is recommended that these be replaced with 62W LED wall packs.

There are (33) 400W metal halide pole lights as street lighting, which are recommended to be replaced with 166W LED pole light heads.

There are (13) 2-Pin CFL sconce fixtures on the community building, which are recommended to be replaced with 25W LED mini wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
C4P-FD-1	65W 4-Pin CFL Flood Light	Building Gables	31W Dual-head LED flood light with motion sensing control	FL2	2 fixtures
MSB-PL-1	400W Metal Halide Pole Light	Street Lighting	166W LED parking lot pole light head(s)	P1-c	33 pole light heads
MSB-WP-1	175W Metal Halide Wall Pack	Building Gables	28W LED wall pack	WP2b	7 fixtures
SSB-WP-1	200W Sodium Vapor Wall Pack	Building Gables	62W LED wall pack	WP3b	36 fixtures
C2P-SC-2	13W 2-Pin CFL Sconce	Community Building	25W LED mini wall pack	WP4	13 fixtures

MC Beldon

The office canopy has (14) 60W CFL can lights. It is recommended that these be replaced with LED bulbs.

There are (28) 150W metal halide wall packs around the building exterior and (1) 150W metal halide wall pack on the maintenance building. It is recommended that these be replaced with 28W LED wall packs.

The (1) 14W screw base CFL decorative wall sconce on the maintenance building is recommended to be replaced with an LED wall sconce.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-CN-1	60W Incandescent Can Light	Around office	10.2W LED Bulb	L7	14 bulbs
MSB-WP-1	150W Metal Halide Wall Pack	Building exteriors	28W LED wall pack	WP2b	28 fixtures
MSB-WP-1	150W Metal Halide Wall Pack	Maintenance building	28W LED wall pack	WP2b	1 fixture
CSB-SC-1	14W Screw Base CFL Sconce	Maintenance building	9W LED wall sconce	WP5	1 fixture

Pin Oak I

There are (2) 150W metal halide pole light and (1) 150W metal halide dual-headed pole light in the parking lot, which are recommended to be replaced with 96W LED pole light heads (for a total of 4 pole light heads).

There are (8) 150W metal halide wall packs around the building exterior. It is recommended that these be replaced with 28W LED wall packs.

There are (14) 60-100W incandescent decorative wall sconces in the walkways and (2) at the community building entry. It is recommended that these be replaced with LED wall sconces.

There are (4) 60-100W surface mount screw-in incandescent fixtures in the stairway and (3) in the community building canopy. It is recommended that these are replaced with 17W LED ceiling fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-PL-1	150W Metal Halide Pole Light	Parking lot	96W LED parking lot pole light head(s)	P1-b	2 pole light heads
MSB-PL-2	150W Metal Halide Dual-headed Pole Light	Parking lot	2x 96W LED parking lot pole light heads	P2-b	2 pole light heads (1 pole)
MSB-WP-1	150W Metal Halide Wall Pack	Building exterior	28W LED wall pack	WP2b	8 fixtures
ISB-SC-1	60/100W Incandescent Sconce	Walkways	9W LED wall sconce	WP5	14 fixtures
ISB-SM-1	60/100W Incandescent Surface Mount	Stairs	17W LED ceiling fixture	LC2	4 fixtures
ISB-SC-1	60/100W Incandescent Sconce	Community building entry	9W LED wall sconce	WP5	2 fixtures
ISB-SM-1	60/100W Incandescent Surface Mount	Community building canopy	17W LED ceiling fixture	LC2	3 fixtures

Pin Oak II

There are (16) 175W mercury vapor walkway pole lights. It is recommended that these pole heads be replaced with 52W LED pole light heads.

There is (1) 175W mercury vapor flood light on the community building. It is recommended that this is replaced with a 51W LED spotlight.

The community building also has (2) screw base CFL decorative wall sconces. It is recommended that these be replaced with LED wall sconces.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MV-PL-1	175W Mercury Walkway Pole Light	walkways	52W LED walkway pole light head	P1-a	11 pole light heads

MV-PL-1	175W Mercury Walkway Pole Light	walkways	52W LED walkway pole light head	P1-a	5 pole light heads
MV-FD-1	175W Mercury Flood Light	Community building	51W LED flag light	WL1	1 fixture
CSB-SC-1	14W Screw Base CFL Sconce	Community building	9W LED wall sconce	WP5	2 fixtures

Raymundo Rangel

There are (3) 250W metal halide pole lights in the parking lot, which are recommended to be replaced with 166W LED pole light heads.

There are (2) 60W incandescent bollards in front of the laundry building and (1) 100W incandescent pole light on the northeast corner of the site. It is recommended that these all be replaced with 52W LED pole light heads.

The canopy of the office building has (6) 2-bulb incandescent flood lights. It is recommended that these be relamped with LEDs. The (1) 13W 2-pin CFL can light at the office building entry should be relamped with LEDs with similar bases.

The 75W flood light in the office building canopy is recommended to be replaced with a motion sensing LED flood light.

There are a couple of 100W screw-in incandescent bulbs that are recommended to be replaced with 10.2W LED screw-in bulbs.

The side of the office building has (1) 150W halogen flood light. It is recommended that this be replaced with a 28W LED wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-PL-1	250W Metal Halide Pole Light	Parking lot	166W LED parking lot pole light head(s)	P1-c	3 pole light heads
ISB-BD-1	60W Incandescent Bollard	In front of laundry building	52W LED walkway pole light head	P1-a	2 pole light heads
ISB-FD-2	100W Incandescent Flood Light	Office building canopy	16.5W LED Bulb	L2	12 bulbs
ISB-FD-1	75W Incandescent Flood Light	Office building corner	21W LED flood light with motion sensing control	FL1	1 fixture
C2P-CN-2	13W 2-Pin CFL Can Light	Office building entry	8.5W LED 2 pin bulb	L5a	2 bulbs
ISB-SM-1	100W Incandescent Surface Mount	Entry gate	10.2W LED Bulb	L7	2 bulbs
ISB-PL-1	100W Incandescent Pole Light	Northeast corner of site	52W LED walkway pole light head	P1-a	1 pole light head

HSB-FD-1	150W Halogen Flood Light	Side of office building	28W LED wall pack	WP2b	1 fixture

Riverside

There are (5) incandescent decorative wall sconces on the community building. It is recommended that these be replaced with LED wall sconces.

There are (15) 65W 4-pin CFL flood lights on the community and residential buildings, which are recommended to be replaced with motion sensing LED flood lights.

There are two types of 175W metal halide wall packs around the building exteriors, for a total of 14 fixtures. It is recommended that these be replaced with 28W LED wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
ISB-SC-1	60W Incandescent Sconce	Community Building	9W LED wall sconce	WP5	5 fixtures
C4P-FD-1	65W 4-Pin CFL Flood Light	Community and Residential	31W Dual-head LED flood light with motion sensing control	FL2	15 fixtures
MSB-WP-1A	175W Metal Halide Wall Pack	Residential	28W LED wall pack	WP2b	12 fixtures
MSB-WP-1B	175W Metal Halide Wall Pack	Residential	28W LED wall pack	WP2b	2 fixtures

Sahara Ramsey

There are (8) 150W metal halide wall packs on the main and laundry buildings. It is recommended that these be replaced with 28W LED wall packs.

The entries have (10) screw base CFL sconce fixtures, which are recommended to be replaced with 9W LED mini wall packs.

The (2) 300W halogen signage flag lights are recommended to be replaced with 51W LED spotlights.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-WP-1	175W Metal Halide Wall Pack	Main buildings and laundry buildings	28W LED wall pack	WP2b	8 fixtures
CSB-SC-1	14W Screw Base CFL Sconce	entries	9W LED wall pack	WP7	10 fixtures
HSB-FG-1	300W Halogen Flag Light	Building signage	51W LED flag light	WL1	2 fixtures

South San

There are (8) 2-Pin CFL sconce fixtures located on the community building, which are recommended to be replaced with 9W LED mini wall packs.

Around the site boundary there are (11) 2-lamp 150W halogen flood lights. It is recommended that each of these be replaced with two 51W LED spotlights.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-PL-1	150W Metal Halide Pole Light	Pathways	36W Screw-in LED bulb	L10b	7 bulbs
C2P-SC-1	13W 2-Pin CFL Sconce	Community Building	9W LED wall pack	WP7	8 fixtures
HSB-FD-2	150W Halogen Flood Light	Around site boundary	2x 51W LED flag light	WL1	22 fixtures

Sun Park Lane

There are (4) 250W metal halide pole lights in the parking lot in the front of the property, which are recommended to be replaced with 166W LED pole light heads.

There are (4) 175W metal halide wall packs on the east, west, and south sides as well as (2) 175W metal halide wall packs on the front of building 3 & 1. It is recommended that these be replaced with 28W LED wall packs.

There are an additional (41) screw-based CFL decorative wall sconces throughout the exterior. It is recommended that these be replaced with LED wall sconces.

The community building, maintenance entry, and back entry have a total of (4) screw-based CFL decorative wall sconces. It is recommended that these be replaced with 9W LED mini wall packs.

The (2) 175W metal halide flood lights on the community building are recommended to be replaced with 62W LED flood lights.

It is recommended that the (3) 400W sodium vapor building-mounted goose-neck fixtures be re-lamped with LED lamps with similar bases.

There are also a few screw-in CFL bulbs in the recessed ceiling entry and back canopy. It is recommended that these be replaced with 10.2W LED screw-in bulbs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-PL-1	250W Metal Halide Pole Light	Front of property parking lot	166W LED parking lot pole light head(s)	P1-c	4 pole light heads
MSB-WP-1	175W Metal Halide Wall Pack	East west south	28W LED wall pack	WP2b	4 fixtures

MSB-WP-	175W Metal Halide Wall Pack	Front building 3, 1	28W LED wall pack	WP2b	2 fixtures
CSB-SC-1	14W Screw Base CFL Sconce	front right left	9W LED wall sconce	WP5	41 fixtures
CSB-SC-1	14W Screw Base CFL Sconce	Community building maintenance entry and back entry	9W LED wall pack	WP7	4 fixtures
MSB-FD-1	175W Metal Halide Flood Light	Community building	62W LED flood light	FL4	2 fixtures
SSB-SM-1	400W Sodium Vapor Goose-neck Fixture	Back of building south	150W Screw-in LED bulb	L10d	3 bulbs
CSB-SM-1	14W Screw Base CFL Surface Mount	Recessed ceiling entry and back canopy	10.2W LED Bulb	L7	6 bulbs

TL Shaley

The office building has (1) 175W metal halide wall pack. It is recommended that this be replaced with a 28W LED wall packs.

There are also a couple of screw-in incandescent bulbs. It is recommended that these be replaced with 10.2W LED screw-in bulbs.

The (3) dual-headed incandescent security lights on the maintenance building are recommended to be replaced with 31W dual-headed LED flood lights with motion sensing control.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-WP-1	150W Metal Halide Wall Pack	Office building	28W LED wall pack	WP2b	1 fixture
ISB-SC-1	60W Incandescent Sconce	Office building	10.2W LED Bulb	L7	2 bulbs
ISB-SM-2	60W Incandescent Dual Headed Security Light	Maintenance building	31W Dual-head LED flood light with motion sensing control	FL2	3 fixtures

Tarry Towne

There are (6) 100W metal halide wall packs and (15) 175W sodium vapor wall packs around the building exterior. It is recommended that these be replaced with 28W LED wall packs.

In the H, G, F, E & C stairs, there are (20) 14/13W 2-Pin/Screw-based CFL sconces. It is recommended that these are replaced with 11W LED ceiling fixtures. In the corridors of these buildings, there are also (20) 4’ T8 fixtures. It is recommended that these be replaced with 4’ LED wrap fixtures.

There are (6) 2-Pin CFL decorative wall sconces on buildings A, B, & D and (44) incandescent and CFL screw-base sconces around the building entries. It is recommended that these be replaced with LED wall sconces.

There are also a number of screw-in incandescent/CFL bulbs in the carports and used as security lighting. It is recommended that these be replaced with 10.2W LED screw-in bulbs. It is recommended that the dual-headed security flood light be replaced with a dual-headed LED flood light.

The (8) ceiling-mounted incandescent and CFL fixtures above the mailboxes are recommended to be replaced with 9W decorative ceiling fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-WP-1	100W Metal Halide Wall Pack	Building exterior	28W LED wall pack	WP2b	6 fixtures
SSB-WP-1	175W Sodium Vapor Wall Pack	Building exterior	28W LED wall pack	WP2b	15 fixtures
T8M4-SM-2	32W 4' T8 Magnetic Ballast Surface Mount	H, G, F, E, C corridor	36W 4' LED surface mounted wrap	RW1	20 fixtures
C2P/CSB-SC-1	14/13W 2-Pin/Screw-base CFL Sconce	H, G, F, E, C stairs	11W LED ceiling fixture	LC3	20 fixtures
C2P-SC-1	14W 2-Pin CFL Sconce	A, B, D	9W LED wall sconce	WP5	6 fixtures
CSB/ISB-FD-2	65/14W Screw Base Incandescent/CFL Flood Light	Carports	10.2W LED Bulb	L7	60 bulbs
CSB/ISB-FD-2	65/14W Screw Base Incandescent/CFL Flood Light	Security	31W Dual-head LED flood light with motion sensing control	FL2	1 fixture
CSB/ISB-FD-1	65/14W Screw Base Incandescent/CFL Flood Light	Security	10.2W LED Bulb	L7	4 bulbs
C2P/CSB-SC-1	14/13W 2-Pin/Screw Base CFL Sconce	Building entries	9W LED wall sconce	WP5	44 fixtures

Villa Veramendi

There are (40) 250W sodium vapor wall packs along the rowhome gables and (1) 250W sodium vapor wall pack at the community center. It is recommended that these be replaced with 62W LED wall packs.

There are (5) 400W metal halide pole lights in the playground, which are recommended to be replaced with 166W LED pole light heads.

There are (9) 65W 4-pin CFL flood lights on the community center, which are recommended to be replaced with motion sensing LED flood lights. There is also a 150W incandescent flood light at the playground which is recommended to be replaced with a motion sensing LED flood light.

There is (1) dual head flood light in the maintenance parking area, which is recommended to be replaced with a dual head motion sensing LED flood light.

The community center canopy has (3) 4' linear fluorescent fixtures. It is recommended that these fixtures be replaced with 36W 4' LED wrap fixtures.

CFL 2-pin bulbs were found in sconces at the community center entries. It is recommended that these be replaced with LED bulbs with similar bases.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
SSB-WP-1	250W Sodium Vapor Wall Pack	Rowhome Gables	62W LED wall pack	WP3b	40 fixtures
MSB-PL-1	400W Metal Halide Pole Light	Playground	166W LED parking lot pole light head(s)	P1-c	5 pole light heads
C4P-FD-1	65W 4-Pin CFL Flood Light	Community Center	21W LED flood light with motion sensing control	FL1	9 fixtures
ISB-FD-1	150W Incandescent Flood Light	Playground	21W LED flood light with motion sensing control	FL1	1 fixture
HSB-FD-2	55W Halogen Flood Light	Maintenance Parking	31W Dual-head LED flood light with motion sensing control	FL2	1 fixture
T12M4-CP-2	4' 2 Bulb T12 Canopy Fixture	Community Center	36W 4' LED surface mounted wrap	RW1	3 fixtures
C2P-SC-1	13W 2-Pin CFL Sconce	Community Center	8.5W LED 2 pin bulb	L5a	3 bulbs
SSB-WP-1	250W Sodium Vapor Wall Pack	Community Center	62W LED wall pack	WP3b	1 fixture

Westway

There are (34) 150W metal halide wall packs around the building exteriors. It is recommended that these be replaced with 28W LED wall packs.

The canopy area has (2) 4' linear fluorescent fixtures. It is recommended that these fixtures be replaced with 32W 4' LED strip fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
MSB-WP-1	150W Metal Halide Wall Pack	Exterior Wall	28W LED wall pack	WP2b	34 fixtures

T8E4-SM-1	32W 4' T8 Electric Ballast Surface Mount	Mounted Under Canopy	32W 4' LED surface mounted strip light	RS4	2 fixtures

William Sinkin

There are (5) CFL ceiling fixtures in the canopy of the community building. It is recommended that these be replaced with 9W decorative LED ceiling fixtures.

The flag has (1) 150W sodium vapor flag spotlight which is recommended to be replaced with a 51W LED spotlight.

Outside each building block are (45) 150W metal halide wall packs, (1) 150W sodium vapor flood light, and (1) 175W mercury vapor wall pack. It is recommended that these all be replaced with 28W LED wall packs.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
CSB-SM-1	14W Screw Base CFL Surface Mount	community building canopy	9W LED decorative ceiling fixture	LC4	5 fixtures
SSB-FG-1	150W Sodium Vapor Flag Light	Flag	51W LED flag light	WL1	1 fixture
MSB-WP-1	150W Metal Halide Wall Pack	outside each building block (2-3 per block)	28W LED wall pack	WP2b	45 fixtures
SSB-FD	150W Sodium Vapor Flood Light	outside a building block	28W LED wall pack	WP2b	1 fixture
MV-WP-1	175W Mercury Vapor Wall Pack	outside building block	28W LED wall pack	WP2b	1 fixture

Williamsburg

Over the back parking lot, there are (8) 4' T8 fixtures with the bulbs end-to-end. It is recommended that these be replaced with 8' LED fixtures.

The canopy over the west porch has (1) 100W sodium vapor fixture and the canopy over the middle porch has (2). It is recommended that these be replaced with 36W LED canopy fixtures.

There is also (1) dual-headed screw-in incandescent fixture lighting the sign. It is recommended that this is replaced with 10.2W LED screw-in bulbs.

There are (7) 100W sodium vapor wall packs on the walls and stairwells. It is recommended that these be replaced with 28W LED wall packs.

There is a building-mounted goose-neck fixture on the west wall with a 100W sodium vapor lamp. It is recommended that this be re-lamped with an LED with a similar base.

There are (12) 14/60W surface mount screw-in CFL/incandescent bulbs in the walkways. It is recommended that these are replaced with 17W LED ceiling fixtures.

Lighting Inventory Tag	Fixture	Location(s)	Replacement Fixture	Replacement Fixture Code	Anticipated Number to Be Replaced
T8M4-SM-4	32W 4' T8 Magnetic Ballast Surface Mount	over back parking lot	57W 1'x8' LED surface mounted fixture	RS6	8 fixtures
SSB-SM-1	100W Sodium Vapor Surface Mount	west porch	36W LED canopy fixture	LC1	1 fixture
SSB-SM-1	100W Sodium Vapor Surface Mount	Middle porch	36W LED canopy fixture	LC1	2 fixtures
ISB-FG-2	65W Incandescent Flag Light	Sign light	10.2W LED Bulb	L7	2 bulbs
SSB-WP-1	100W Sodium Vapor Wall Pack	Walls and stairwells	28W LED wall pack	WP2b	7 fixtures
SSB-SM-1	100W Sodium Vapor Goose-neck Fixture	West wall	24W Screw-in LED bulb	L10a	1 bulb
ISB/CSB-SM-1	14/60W CFL/Incandescent Surface Mount	Walkways	17W LED ceiling fixture	LC2	12 fixtures

Impacts to Operations and Maintenance:

The equipment life of the new lighting fixtures is expected to be 10 years, which will reduce maintenance costs since they will not need to be replaced as often. No repairs are required for this measure to be effective. No new skills are required.

Impacts to Residents:

This measure will not impact occupant health. The lighting levels will not be lowered, but could be improved by the new lighting, which would improve occupant comfort and safety. The new pole lights are integrated with a multi-level motion sensor, which will provide a lower light level when the area is unoccupied. This provides a measure of safety to residents, since the light increasing to full output signals an occupant in the area.

Pricing and Site Specific Installation Notes to Contractor:

Basis of design products are provided in the related specifications. Contractor should verify that replacement fixtures are compatible with current wiring configurations. Remediation of any wiring issues should be provided as a separate cost in the proposal. The positioning of new lighting should be cleared with SAHA prior to installation. Any concerns with retrofit mounting location, matching existing lighting distribution, or meeting electrical requirements should be coordinated with SAHA prior to install or purchase of fixtures.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									Total Energy Savings
		Water & Sewer			Electricity			Natural Gas			
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Villa Veramendi	HE Lighting - Exterior	-	-	-	26,958	$ 0.12380	$ 3,337	-	-	-	$ 3,337
Sun Park Lane	HE Lighting - Exterior	-	-	-	10,286	$ 0.10270	$ 1,056	-	-	-	$ 1,056
Frank Hornsby	HE Lighting - Exterior	-	-	-	17,800	$ 0.10270	$ 1,828	-	-	-	$ 1,828
Mission Park	HE Lighting - Exterior	-	-	-	54,623	$ 0.11540	$ 6,303	-	-	-	$ 7,219
Tarry Towne	HE Lighting - Exterior	-	-	-	20,157	$ 0.10080	$ 2,032	-	-	-	$ 2,032
Escondida	HE Lighting - Exterior	-	-	-	7,517	$ 0.10080	$ 758	-	-	-	$ 758
Williamsburg	HE Lighting - Exterior	-	-	-	6,016	$ 0.10080	$ 606	-	-	-	$ 5,485
Matt Garcia	HE Lighting - Exterior	-	-	-	10,498	$ 0.08870	$ 931	-	-	-	$ 931
Blanco	HE Lighting - Exterior	-	-	-	4,415	$ 0.09560	$ 422	-	-	-	$ 422
Lewis Chatham	HE Lighting - Exterior	-	-	-	9,010	$ 0.09080	$ 818	-	-	-	$ 818
Linda Lou	HE Lighting - Exterior	-	-	-	240	$ 0.12400	$ 30	-	-	-	$ 30
Riverside Apts	HE Lighting - Exterior	-	-	-	10,929	$ 0.12400	$ 1,355	-	-	-	$ 1,355
Linda Lou	HE Lighting - Exterior	-	-	-	359	$ 0.12400	$ 45	-	-	-	$ 45
Midway	HE Lighting - Exterior	-	-	-	1,581	$ 0.12400	$ 196	-	-	-	$ 196
Madonna	HE Lighting - Exterior	-	-	-	15,461	$ 0.10580	$ 1,636	-	-	-	$ 1,636
Sahara Ramsey	HE Lighting - Exterior	-	-	-	6,558	$ 0.10580	$ 694	-	-	-	$ 694
Cheryl West	HE Lighting - Exterior	-	-	-	16,194	$ 0.22910	$ 3,710	-	-	-	$ 3,710
T. L. Shaley	HE Lighting - Exterior	-	-	-	1,658	$ 0.22910	$ 380	-	-	-	$ 380
Jewett Circle	HE Lighting - Exterior	-	-	-	12,068	$ 0.10460	$ 1,262	-	-	-	$ 1,262
Col. Cisneros	HE Lighting - Exterior	-	-	-	9,535	$ 0.10460	$ 997	-	-	-	$ 997
Highview Apts	HE Lighting - Exterior	-	-	-	39,460	$ 0.09660	$ 3,812	-	-	-	$ 3,812
William Sinkin	HE Lighting - Exterior	-	-	-	22,806	$ 0.09660	$ 2,203	-	-	-	$ 2,203
Cross Creek	HE Lighting - Exterior	-	-	-	16,923	$ 0.15410	$ 2,608	-	-	-	$ 2,608
Morris C. Beldon	HE Lighting - Exterior	-	-	-	15,906	$ 0.15410	$ 2,451	-	-	-	$ 2,451
L.C. Rutledge	HE Lighting - Exterior	-	-	-	14,667	$ 0.15410	$ 2,260	-	-	-	$ 2,260
Westway	HE Lighting - Exterior	-	-	-	16,394	$ 0.15420	$ 2,528	-	-	-	$ 2,528
H.B. Gonzalez	HE Lighting - Exterior	-	-	-	14,924	$ 0.15420	$ 2,301	-	-	-	$ 2,301
Pin Oak II	HE Lighting - Exterior	-	-	-	14,929	$ 0.14370	$ 2,145	-	-	-	$ 2,145
Lila Cockrell	HE Lighting - Exterior	-	-	-	7,170	$ 0.12170	$ 873	-	-	-	$ 873
South San	HE Lighting - Exterior	-	-	-	10,319	$ 0.12170	$ 1,256	-	-	-	$ 1,256
Raymundo Rangel	HE Lighting - Exterior	-	-	-	5,881	$ 0.11820	$ 695	-	-	-	$ 695
Mirasol Townhomes	HE Lighting - Exterior	-	-	-	14,834	$ 0.11820	$ 1,753	-	-	-	$ 1,753
Christ the King	HE Lighting - Exterior	-	-	-	16,194	$ 0.11820	$ 1,914	-	-	-	$ 1,914
Pin Oak I	HE Lighting - Exterior	-	-	-	9,866	$ 0.10080	$ 994	-	-	-	$ 994

Calculation Methodology:

The savings is evaluated by multiplying the change in lighting load by the typical runtime hours as shown.

$$kWh\ Savings = (Existing\ Load - New\ Load) \times Hrs \times Nbr\ Lamps \frac{kW}{1000W}$$

Existing Load = Wattage of Existing Lamp/Fixture

New Load = Wattage of New Lamp/Fixture

Hrs – Annual hours of operation (4,005 sundown hours)

Nbr Lamps – Number of similar lamps/fixtures undergoing replacement

All savings calculation details can be found within the “SAHA Phase II Savings Calculator” excel spreadsheet that has been provided as a supplement to this report.

5.2.4 In-Unit Heat Lamp Retrofit – ECM 2-240

Site Name	Project #	Count and Descriptions		
Sun Park Lane	TX06-6023.0	65	HL1	Low wattage heat lamps (125W)
Mission Park	TX06-6024.0	100	HL1	Low wattage heat lamps (125W)
Escondida	TX06-6033.1	20	HL1	Low wattage heat lamps (125W)
Sahara Ramsey	TX06-6032.2	16	HL1	Low wattage heat lamps (125W)
Cheryl West	TX06-6034.0	88	HL1	Low wattage heat lamps (125W)
Jewett Circle	TX06-6038.0	75	HL1	Low wattage heat lamps (125W)
William Sinkin	TX06-6052.0	50	HL1	Low wattage heat lamps (125W)
H.B. Gonzalez	TX06-6051.0	51	HL1	Low wattage heat lamps (125W)
Lila Cockrell	TX06-6058.0	70	HL1	Low wattage heat lamps (125W)
Spring View	TX06-6136.0	222	HL1	Low wattage heat lamps (125W)
Pin Oak I	TX06-6054.1	50	HL1	Low wattage heat lamps (125W)
TOTAL		**873**	**HL1**	**Low wattage heat lamps (125W)**

There were a number of sites that had high wattage heat lamps. It is recommended that these be replaced with 125 watt heat lamps.

There are also heat lamps in the second bathrooms (4 bedroom units) at Cheryl West. The 4 and 5 bedroom units at Mission Park have second bathrooms, but these do not have heat lamps.

At Spring View, this heat lamp retrofit only affects the senior site units.

Improvements to Operations and Maintenance:

This measure will have no impact on operating or maintenance costs. No repairs are required for this measure to be effective and no new skills are required.

Impacts to Residents:

This measure will not impact occupant health.

Pricing and Site-Specific Installation Notes to Contractor:

Basis of design products are listed in the specification. Please provide pricing based on counts listed in the table above. Also, provide a per unit add/deduct (material and labor) for lamps, as well as an allowance as a separate line item for the installation of an additional 10% of lamps. It is the responsibility of the contractor to obtain the final heat lamp counts. Any concerns with retrofit mounting location or meeting electrical requirements should be coordinated with SAHA prior to install or purchase of fixtures.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									
		Water & Sewer			Electricity			Natural Gas			Total Energy Savings
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Sun Park Lane	Bthrm Heat Lamps	-	-	-	3,425	$ 0.12154	$ 416	-	-	-	$ 416
Mission Park	Bthrm Heat Lamps	-	-	-	5,292	$ 0.11546	$ 611	-	-	-	$ 611
Escondida	Bthrm Heat Lamps	-	-	-	1,080	$ 0.10080	$ 109	-	-	-	$ 109
Sahara Ramsey	Bthrm Heat Lamps	-	-	-	855	$ 0.11690	$ 100	-	-	-	$ 100
Cheryl West	Bthrm Heat Lamps	-	-	-	4,139	$ 0.11705	$ 484	-	-	-	$ 484
Jewett Circle	Bthrm Heat Lamps	-	-	-	4,050	$ 0.10460	$ 424	-	-	-	$ 424
William Sinkin	Bthrm Heat Lamps	-	-	-	2,614	$ 0.11951	$ 312	-	-	-	$ 312
H.B. Gonzalez	Bthrm Heat Lamps	-	-	-	2,543	$ 0.11461	$ 291	-	-	-	$ 291
Lila Cockrell	Bthrm Heat Lamps	-	-	-	3,708	$ 0.11308	$ 419	-	-	-	$ 419
Spring View Scat.	Bthrm Heat Lamps	-	-	-	984	$ 0.11560	$ 114	-	-	-	$ 114
Spring View	Bthrm Heat Lamps	-	-	-	6,791	$ 0.11520	$ 782	-	-	-	$ 782
Pin Oak I	Bthrm Heat Lamps	-	-	-	2,646	$ 0.12150	$ 321	-	-	-	$ 321

Calculation Methodology:
The savings is evaluated by multiplying the change in heat lamp load by the typical runtime hours as shown.

$$kWh\ Savings = (Existing\ Load - New\ Load) \times Hrs \times Nbr\ Lamps \times \frac{kW}{1000W}$$

Existing Load = Wattage of Existing Lamp

New Load = Wattage of New Lamp

Hrs – Annual hours of operation by space time (432 annual hours)

Nbr Lamps – Number of lamps to be replaced

For Authority paid sites, all savings calculation details can be found within the “SAHA Phase II Savings Calculator” excel spreadsheet that has been provided as a supplement to this report. Resident paid site details can be found within the “SAHA EPC Phase II RPU Calculator”.

5.2.5 In-Unit Exhaust Fan Retrofit – ECM 2-241

Site Name	Project #	Count and Descriptions		
Frank Hornsby	TX06-6124.0	59	EF1	Energy Star exhaust fan
		59	HL2	125W heat lamp fixture
T. L. Shaley	TX06-6057.0	70	EF1	Energy Star exhaust fan
		70	HL2	125W heat lamp fixture
Cross Creek	TX06-6044.0	66	EF1	Energy Star exhaust fan
		66	HL2	125W heat lamp fixture

L.C. Rutledge	TX06-6056.0	66	EF1	Energy Star exhaust fan
		66	HL2	125W heat lamp fixture
Christ the King	TX06-6143.0	48	EF1	Energy Star exhaust fan
		48	HL2	125W heat lamp
Spring View	TX06-6140.0	40	EF1	Energy Star exhaust fan
		40	HL2	125W heat lamp fixture
TOTAL		**349**	**EF1**	**Energy Star exhaust fan**
		349	**HL2**	**125W heat lamp fixture**

At some sites, the bathroom exhaust fans have high wattage integrated heating elements. It is recommended that these exhaust fans be replaced with Energy Star exhaust fans without a heating element and a separate heat lamp fixture be installed.

At LC Rutledge, there are a mix of exhaust fan integrated heating elements and units with a separate heat lamp.

Improvements to Operations and Maintenance:

This measure will have no impact on operating or maintenance costs. No repairs are required for this measure to be effective and no new skills are required.

Impacts to Residents:

Exhaust fans may not be functioning correctly in all units. New exhaust fans will ensure proper exhaust and help reduce the incidence of mold.

Pricing and Site-Specific Installation Notes to Contractor:

Basis of design products are listed in the specification. Please provide an allowance as a separate line item for the installation of an additional 10% of exhaust fans and heat lamp fixtures. It is the responsibility of the contractor to obtain the final counts, as well as ensure that the final size and positioning/mounting of the exhaust fan replacements makes the most sense for the space. The positioning of the new heat lamps should be cleared with SAHA prior to installation. Any concerns with retrofit mounting location or meeting electrical requirements should be coordinated with SAHA prior to install or purchase of fixtures.

At LC Rutledge, there are a mix of exhaust fans with heating elements and separate heat lamps. Please price out as if replacing 100% of exhaust fans and installing new heat lamp fixtures (count as in table above) and offer a per apartment deduct for any apartment that requires just a heat lamp replacement.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									Total Energy Savings
		Water & Sewer			Electricity			Natural Gas			
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Frank Hornsby	Bthrm Heat Lamps & Fans	-	-	-	34,198	$ 0.11429	$ 3,908	-	-	-	$ 3,908
T. L. Shaley	Bthrm Heat Lamps & Fans	-	-	-	42,768	$ 0.11652	$ 4,983	-	-	-	$ 4,983
Cross Creek	Bthrm Heat Lamps & Fans	-	-	-	40,446	$ 0.11713	$ 4,738	-	-	-	$ 4,738
L.C. Rutledge	Bthrm Heat Lamps & Fans	-	-	-	43,062	$ 0.11689	$ 5,034	-	-	-	$ 5,034
Christ the King	Bthrm Heat Lamps & Fans	-	-	-	28,071	$ 0.11380	$ 3,194	-	-	-	$ 3,194
Spring View Sr.	Bthrm Heat Lamps & Fans	-	-	-	21,652	$ 0.11355	$ 2,459	-	-	-	$ 2,459

Calculation Methodology:

The savings is evaluated by multiplying the change in heat lamp load by the typical runtime hours as shown.

$$kWh\ Savings = (Existing\ Load - New\ Load) \times Hrs \times \frac{kW}{1000W}$$

Existing Load = Wattage of Existing Lamp & Fan

New Load = Wattage of New Lamp & Fan

Hrs – Annual hours of operation by space time

For Authority paid sites, all savings calculation details can be found within the "SAHA Phase II Savings Calculator" excel spreadsheet that has been provided as a supplement to this report. Resident paid site details can be found within the "SAHA EPC Phase II RPU Calculator".

5.3 Envelope

5.3.1 Window Replacement – ECM 2-310

Site Name	Project #	Count and Descriptions		
Col. Cisneros	TX06-6054.0	169	WI	Replace windows with new double-paned vinyl windows at U-0.32 or less
Total		**169**	**WI**	**Replace windows with new double-paned vinyl windows at U-0.32 or less**

Existing Conditions

Colonel Cisneros

The windows at Colonel Cisneros have old glazing and deteriorating frames that are beyond their expected life. The existing windows are single pane in kitchens, bedrooms, and living rooms with metal frames. Windows are single hung with approximate dimensions of 3'x3' in the kitchen and 3' x 6' in the living room and bedroom. It is recommended that these windows are replaced with operational windows that meet the guidelines below. Existing sliding glass doors are double pane and should not be replaced.

New Window Replacement Guidelines

Replacing these windows with standard low-e, double-pane windows with a good fit and a tight seal is recommended. The replacement windows should have a U-factor of less than 0.32 Btu/hr-ft2-F and an SHGC of 0.25 or less.

The new window scope must also meet the following guidelines:

1. **Replacement windows shall be flush fin replacement windows allowing the existing window frame to be left in place and concealed. The owner preference is for Milgard manufactured windows with Z-Bar installation. Alternative products must be approved by the owner.**
2. The new windows must comply with the design wind load, air water and structural test performance requirements detailed in the specification.
3. Condensation Resistance Factor (CRF) requirements shall be minimum 52 (Frame) and minimum 66 (Glass). Visible Transmittance rating shall not be less than 0.60.
4. The installation shall meet or exceed HUD Minimum Property Standards, as well as State and Local Codes for all testing requirements, and be compliant with any local historical building status requirements.

5. New windows should preserve or improve the structural integrity provided by the existing windows.
6. Refer to performance-based specifications of this report.
    - 013300 – SUBMITTAL PROCEDURES
    - 014000 – QUALITY REQUIREMENTS
    - 017823 – OPERATION AND MAINTENANCE DATA
    - 017839 – PROJECT RECORD DOCUMENTS
    - 019113 – GENERAL COMMISSIONING REQUIREMENTS
    - 088000 – GLAZING

Impacts to Operations and Maintenance:

New windows should have a longer life than the existing windows and minimize future window-related operations and maintenance issues.

Impacts to Residents:

The increased insulation level and solar heat gain protection should make occupants feel more comfortable. Additionally, tightly installed windows should reduce the draftiness of the windows.

Pricing and Site-Specific Installation Notes to Contractor:

The contractor should determine the final number of windows to be replaced and appropriate sizes for a good fit to the existing openings. NFRC or equivalent performance stickers should be left on the windows until SAHA staff has had an opportunity to verify the performance properties. Water infiltration will be tested on site in accordance with ASTM E 1105 by the CxA for two mock-up windows.

To reduce impact on residents, the contractor must be appropriately staffed to allow the installation crew to install ECMs at an efficient pace.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									Total Energy Savings
		Water & Sewer			Electricity			Natural Gas			
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Col. Cisneros	Window Replacement	-	-	-	19,646	$ 0.11327	$ 2,225	-	-	-	$ 2,225

Calculation Methodology:

The efficiency of the baseline heating system was found by the weighted average (by installed capacity) of the efficiencies of all the models of heating systems found at the property. The net heating load and savings are calculated within the SAHA EPC Phase II RPU Calculator. The savings are based on the following formulas:

$$Heating\ Load = \frac{24\frac{hr}{day} \times HDD \times Peak}{\Delta T}$$

HDD – Annual heating degree days for San Antonio @65 ºF = 1644

ΔT – Temperature difference between inside and outside (at peak low) = 50ºF

$$Peak = Perimeter + Walls + Windows + Doors + Roof + Infiltration$$

Walls, Windows, Doors, and Roof are calculated as:

$$Area \times Uvalue \times \Delta T$$

$$Perimeter = Linear\ Ft \times Heat\ Loss\ Coefficient \times \Delta T$$

$$Infiltration = c_p \times Leakage\ Area \times \Delta T$$

c_p – Sensible heat of air = 1.08$\frac{Btu}{CFM \times F}$

$$Windows\% = \frac{Windows_{ex} - Windows_{new}}{Peak_{ex} - Peak_{new}}$$

$Windows_{ex}$ – Existing roof as above

$Windows_{new}$ – New roof as above, takes into account any anticipated changes in the u-value due to recommended improvements

$Peak_{ex}$ – Existing peak load as above

$Peak_{new}$ – New peak load as above, takes into account any anticipated changes in the peak load due to all recommended envelope improvements

$$Heating\ Savings = \frac{Existing\ Heating\ Load}{Existing\ Average\ Heating\ Efficiency} - \frac{Replacement\ Heating\ Load}{Replacement\ Efficiency}$$

Replacement Heating Load – Takes into account any anticipated changes in the heating load due to recommended envelope improvements

$$Window\ Savings = Window\% \times Heating\ Savings$$

The following table lists the value for each of these variables used to calculate the savings expected for each of these properties:

Site Name	Existing Window U-value	New Window U-value
Col. Cisneros	1.20	0.32

5.4 Mechanical

5.4.1 Electric Furnace and Condensing Unit to Split System Heat Pump – ECM 2-410

Site Name	Project #	Count and Descriptions		
Frank Honsby	TX06-6124.0	59	HP	9.5 HSPF heat pumps
Westway	TX06-6047.0	152	HP	9.5 HSPF heat pumps
Lila Cockrell	TX06-6058.0	70	HP	9.5 HSPF heat pumps
South San	TX06-6130.0	30	HP	9.5 HSPF heat pumps
Christ the King	TX06-6143.0	48	HP	9.5 HSPF heat pumps
TOTAL		**359**	**HP**	**9.5 HSPF heat pumps**

The space conditioning system at these properties consists of a split AC system with electric resistance heating located in a closet in each unit. The air-cooled condensing units currently provide cooling-only. The replacement of these systems with split heat pump systems is recommended. The new systems should be rated to achieve 9.5 HSPF (and 16 SEER in cooling mode). Because the current systems use R-22 refrigerant, a new refrigerant coil will be required and refrigerant piping will need to be flushed and cleaned. It is recommended that thermostats are installed to take full advantage of the energy efficiency performance of the new system.

Please consider the following when assembling pricing:

- Additional wires may need to be run between the furnace and new thermostat. This cost must be included in the bid.
- Provide a non-programmable digital thermostat with the ability to take advantage of the staging and the ability to operate in fan only mode.
- A Manual J compliant load calculation and Manual S compliant sizing must be performed to properly size the new heat pumps. All load and sizing calculations shall be submitted to the owner and commissioning agent for approval before any equipment is ordered. Please also remember to take into consideration the size of the existing fan coil unit and utilize it again if possible.
- A sticker prompt should be included to encourage a 66°F nighttime set point and a 70°F daytime set point for heating. The sticker design will be provided by the owner, but the contractor will be responsible for printing and installing the prompt.
- All visible and accessible ducts shall be sealed with a SMACNA approved material.
- Install turning vanes in all T and elbow duct fittings accessible from the furnace. Turning vanes can be single wall.
- Provide new refrigerant coils for electric furnaces that are sized appropriately for the calculated load and existing furnace blower.
- Refrigerant piping should be flushed and prepared for new refrigerant with an appropriate cleaning method. If any piping cannot be adequately cleaned to ensure proper operation of new equipment, then refrigerant piping shall be replaced. See pricing notes for refrigerant piping contingencies.
- All equipment shall be started per manufacturer requirements. Also include documentation of proper airflow, filtration, gas pressure, temperature rise, and controls configuration. Start-up documentation shall be left on site and submitted to the owner and commissioning agent. A sample start up report shall be included in the bid specifications.
- Refer to performance-based specifications of this report.
    - 013300 – SUBMITTAL PROCEDURES
    - 014000 – QUALITY REQUIREMENTS
    - 017823 – OPERATION AND MAINTENANCE DATA
    - 017900 – DEMONSTRATION AND TRAINING
    - 019113 – GENERAL COMMISSIONING REQUIREMENTS
    - 238126 SF – SPLIT-SYSTEM AIR-CONDITIONERS & HEAT PUMPS
    - All other applicable division 22 and 23 specs.

Improvements to Operations and Maintenance:

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

Impacts to Residents:

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

Pricing and Site-Specific Installation Notes to Contractor:

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.

Clean and reuse existing line set. Note that previous install has R-22 refrigerant. Please include allowance for replacing refrigerant piping at 25% of units. All reused piping needs to be thoroughly flushed. Contractor to provide a 2 year warranty against acid burnout of the heat pump.

Please include an allowance for new electrical service to heat pump units at 25% of units. Please include an allowance for concrete pads that are beyond useful life (assume 25% of units).

This will be a design build effort, but for the purposes of standard pricing, please assume Carrier Infinity 16 (15HNB6) heat pumps will be used. Size heat pumps for heat at 30 btu/SF for pricing purposes. Before final equipment selection, contractor shall be responsible for load calculation and equipment sizing per specifications. **It should be noted that the contractor is ultimately responsible for verifying site conditions.**

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									
		Water & Sewer			Electricity			Natural Gas			Total Energy Savings
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Frank Hornsby	Heat Pumps	-	-	-	110,682	$ 0.11429	$ 12,650	-	-	-	$ 12,650
Westway	Heat Pumps	-	-	-	467,502	$ 0.11576	$ 54,118	-	-	-	$ 54,118
Lila Cockrell	Heat Pumps	-	-	-	138,364	$ 0.11308	$ 15,646	-	-	-	$ 15,646
South San	Heat Pumps	-	-	-	55,216	$ 0.11405	$ 6,297	-	-	-	$ 6,297
Christ the King	Heat Pumps	-	-	-	68,799	$ 0.11380	$ 7,829	-	-	-	$ 7,829

Calculation Methodology:
The net heating load and savings are calculated within the SAHA EPC Phase II RPU Calculator. The savings are based on the following formulas:

$$Heating\ Load = \frac{24\frac{hr}{day} \times HDD \times Peak}{\Delta T}$$

HDD – Annual heating degree days for San Antonio @65 ºF = 1644

ΔT – Temperature difference between inside and outside (at peak low) = 50ºF

$$Peak = Perimeter + Walls + Windows + Doors + Roof + Infiltration$$

Walls, Windows, Doors, and Roof are calculated as

$$Area \times Uvalue \times \Delta T$$

$$Perimeter = Linear\ Ft \times Heat\ Loss\ Coefficient \times \Delta T$$

$$Infiltration = c_p \times Leakage\ Area \times \Delta T$$

c_p – Sensible heat of air = 1.08$\frac{Btu}{CFM \times F}$

$$Savings = \left(\frac{Ex\ Heat\ Load}{Existing\ COP} - Ex\ Heat\ Load\right) - \left(\frac{New\ Heat\ Load}{New\ COP} - New\ Heat\ Load\right) - Envelope\ Savings$$

Envelope Savings – Savings already attributed to envelope improvements

New Heating Load – Takes into account any anticipated changes in the heating load due to recommended envelope improvements

Existing COP – 1.0

New COP – 2.78

5.4.2 Central Plant Boiler Replacement – ECM 2-420

Site Name	Project #	Count and Descriptions		
Blanco	TX06-6029.0	1	B1	Install New Modular Power Draft Space Heating Boiler Plant with Setpoint Enable and OA Reset Controls
TOTAL		**1**	**B1**	**Install New Modular Power Draft Space Heating Boiler Plant with Setpoint Enable and OA Reset Controls**

Blanco is served by two (2) atmospheric, natural gas Ajax boilers (1,600 MBH output each) in primary/secondary configuration. Each boiler has a 1 HP primary pump, and the secondary loop has three (3) constant volume distribution pumps. These pumps each serve zones with 2-pipe fan coils within the building. Those three pumps are 7.5 HP (Zone 1), 10 HP (Zone 2), and 1.5 HP (Zone 3).

It is recommended that the existing space heating boilers be replaced with at least two (2) modulating power draft boilers. The new boilers shall be designed so that each can handle 2/3 of peak heating load. Contractors shall perform heat loss calculations to determine the necessary capacity of the new boilers without oversizing. If more than two (2) 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%). Boilers shall have a minimum turn-down ratio of 5:1.

The new system scope should include the following:

1. A new boiler control system shall be installed to operate the boilers and pumps with the following sequence of control:
    a. *Enable boilers when the outside air temperature falls below 62F (adj.). Disable boilers when outside air temperature rises above 65F (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 unless otherwise noted.*
    b. *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 the design outdoor air condition, 0 F (Adj.), and a lower, 160 F (Adj.) HWS is delivered at the high outdoor air temperature, 60 F (Adj.). This reset is to be optimized to maintain at least 135F at the furthest radiator.*

    The following provides a schematic of a potential 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.*

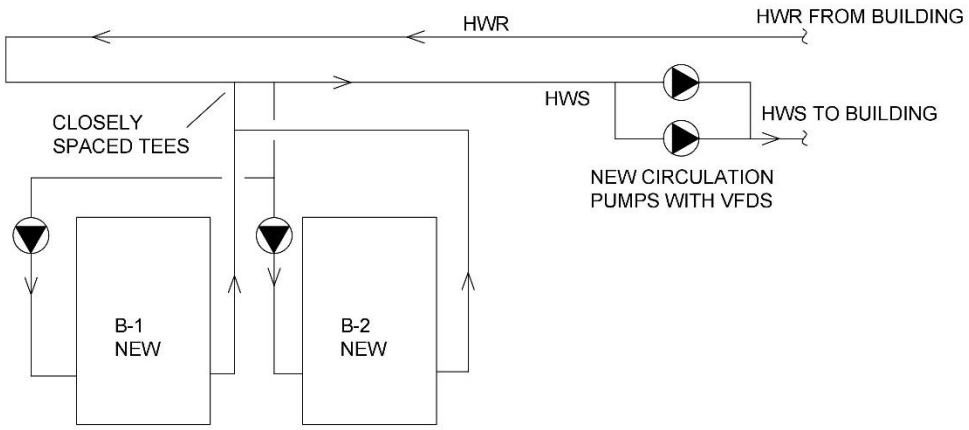


Figure 1 – New Space Heating Boiler Piping Diagram

2. Provide proper venting per manufacturer guidelines. The combustion air intake and flues of the boilers shall be engineered to meet manufacturer's requirements and code. Flue paths should be approved by the owner prior to installation. Combustion air shall be direct vented to the outdoors. 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 needed. This shall be coordinated with the domestic hot water plant as well.
3. Contractor shall perform a load calculation and submit to the owner so the equipment can be correctly sized. A like-for-like replacement will not be accepted and equipment will not be released until load calculations have been approved. For pricing purposes only a like for like can be utilized. Final pricing to reflect final contractor pricing.
4. Contractor shall coordinate and program the boiler plant controls. The Contractor shall document all installed setpoints, provide documentation to the owner, and fully train the Owner on setpoint adjustment. All controls shall be electronic and all pneumatics shall be removed. Laminated as-build control drawings shall be present on site.
5. 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.
6. Piping and pumping shall meet the following requirements:
    a. New secondary pumps shall be equipped with VFD's **if** electronic zone valves are included in the project scope or **if** the radiators are equipped with another 2-way control valve. Pumps shall be capable of self-modulating flow based upon a constant differential pressure as set by a certified test and balance contractor to maintain flow at the furthest most radiator. Pumps shall also be interlocked with the boiler plant and only operate while the plant is operating. Constant volume bypass valves shall also be installed at the top of each riser to ensure that a small amount of water flow is always running through the system hot water piping.
    b. One line piping diagram shall be provided to owner prior to ordering any equipment.
    c. Piping to be equipped with the necessary means to meet the test and balance requirements.
    d. Insulate all exposed hot water piping.
7. Contractor should train Owner personnel on how to operate the boiler plant and adjust setpoints. O&M's to be left onsite in an area designated by the owner. Control drawings and as-built conditions to be laminated left in the temperature control panel.

8. 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.
9. The Contractor shall provide a full and operational system including but not limited to the electrical work, flues, combustion air, natural gas piping, equipment and piping supports, anchors, pumps, boilers and associated controls.
10. The contractor shall hire a qualified test and balance contractor. The contractor shall be TAB, NEBB or equivalent certified. Test and balance contractor shall ensure that the boiler plants are meeting the minimum flow requirements both through the boiler themselves and to the furthest most hydronic heating equipment.
11. 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.
12. The Contractor shall secure all permits and inspections required for demolition and installation.
13. The Contractor shall work with and assist the Owner's Commissioning Agent to commission the plant operation.
14. Refer to performance-based specifications of this report.
    - 013300 – SUBMITTAL PROCEDURES
    - 014000 – QUALITY REQUIREMENTS
    - 017823 – OPERATION AND MAINTENANCE DATA
    - 017839 – PROJECT RECORD DOCUMENTS
    - 017900 – DEMONSTRATION AND TRAINING
    - 019113 – GENERAL COMMISSIONING REQUIREMENTS
    - All other applicable division 22 and 23 specs.

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.

Pricing and Site Specific Installation Notes to Contractor:

This will be a design build effort, but for the purposes of standard pricing, please assume two (2) Lochinvar PBN2001 boilers will be used. 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.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									Total Energy Savings
		Water & Sewer			Electricity			Natural Gas			
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Blanco	Boiler Upgrade	-	-	-	-	-	-	2,204	$ 0.7871	$ 1,735	$ 1,735

Calculation Methodology:
The savings is evaluated by multiplying the annual gas use by existing plant efficiency and dividing by the new plant efficiency. The savings are calculated within the SAHA EPC Phase II RPU Calculator. The savings are based on the following formula:

$$Total\ Savings = Annual\ Gas\ Use - \frac{Annual\ Gas\ Use \times Existing\ Efficiency}{New\ Effciency}$$

Annual Gas Use – Total Annual Gas Use of Existing Boiler – ccf/year

Existing Efficiency – Existing Boiler Efficiency - %

New Efficiency – Replacement Boiler Efficiency - %

Site Name	Annual Gas Use (ccf/year)	Existing Plant Efficiency	New Plant Efficiency	Post Retrofit Gas Use (ccf/yr)	Total Savings
Blanco	15,000	80%	95%	12,632	2,368

5.4.3 Domestic Hot Water Plant Replacement – ECM 2-420 (cont.)

Site Name	Project #	Count and Descriptions		
Blanco	TX06-6029.0	1	HW	Install New Condensing Domestic Hot Water Plant
TOTAL		**1**	**HW**	**Install New Condensing Domestic Hot Water Plant**

Existing Condition:

Blanco Apartments domestic hot water for the building is provided by one (1) Raypak H3-0511 511MBH boiler connected to an approximately 500 gallon storage tank. The storage tank temperature was set to 115°F.

Efficiency Measure:

Replace the atmospheric water heater with at least two (2) high efficiency condensing domestic water boilers (95% efficiency). Replacement of the storage tank and DHW recirculation pumps should be included in the scope of the upgrade.

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 new recirculation pump shall have an EC motor and be able to automatically maintain a minimum temperature in the recirculation line. The recirculation pump should be sized to meet the calculated pressure loss of the longest piping run including any mixing valves. Pressure loss calculations should be submitted with the pump submittal.
4. 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.

5. The Contractor shall install, test, and balance a 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.
6. 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.
7. The Contractor shall secure all permits and inspections required for demolition and installation.
8. 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.
9. Provide proper venting for water heaters. The combustion air and flues shall be engineered to meet manufacturer's requirements and code. Flue paths should be approved by the owner prior to installation. Water heaters shall be direct vent capable and old combustion air openings shall be sized in conjunction with boilers plants and sized reduced where possible or sealed completely.
10. If applicable, the Contractor shall work with and assist the Owner's Commissioning Agent to commission the plant operation.
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.
12. Refer to performance-based specifications of this report.
    - 15514 – DOMESTIC WATER HEATERS
    - 220513 – COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT
    - 232123 – HYDRONIC PUMPS
    - 235216 – CONDENSING BOILERS
    - All other applicable division 22 and 23 specs.

Improvements to Operations and Maintenance:

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

Pricing and Site Specific Installation Notes to Contractor:

This will be a design build effort, but for the purposes of standard pricing, please assume two (2) Lochinvar AWN400PM boilers with three (3) Lochinvar RJS120M storage tanks will be used. Before final equipment selection, contractor shall be responsible for load calculation and equipment sizing per specifications for domestic hot water plant. **It should be noted that the contractor is ultimately responsible for verifying site conditions.** Contractor will be responsible for issuing a deduction if plant has been reduced significantly in size.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									Total Energy Savings
		Water & Sewer			Electricity			Natural Gas			
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Blanco	Boiler Upgrade	-	-	-	-	-	-	2,204	$ 0.7871	$ 1,735	$ 1,735

Calculation Methodology:

See section 5.4.2 for boiler upgrade calculations as the calculation methodology for this measure.

5.5 Renewable Energy

5.5.1 New Roof and Solar PV – ECM 2-510

Site Name	Project #	Count and Descriptions		
Blanco	TX06-6029.0	1	PV1	Install a roof mounted photovoltaic system
Blanco	TX06-6029.0	1	RPV1	Replace Roof

At Blanco Apartments, a roof top mounted PV system is recommended. with a goal of maximizing efficiency and sizing the system to offset as much of the buildings load as possible without generating excess electricity ("kWh"). The age of the roof necessitates its replacement with a new TPO roof as part of the Solar PV installation.

The following performance-based specification sections are related to this scope of work (note: some information in the specifications may relate to other scopes of work and may not be germane to this scope of work):

- 013300 – SUBMITTAL PROCEDURES
- 014000 – QUALITY REQUIREMENTS
- 017823 – OPERATION AND MAINTENANCE DATA
- 017900 – DEMONSTRATION AND TRAINING
- 019113 – GENERAL COMMISSIONING REQUIREMENTS
- ROOF REPLACEMENT
- MINIMUM SOLAR TECHNICAL SPECIFICATION

Improvements to Operations and Maintenance:

The installation of PV systems will have little impact on the operations and maintenance ("O&M") of the site. PV systems require very little O&M on a routine basis and SAHA is seeking pricing for a third party local solar contractor to provide annual O&M.

Impacts to Residents:

The PV systems will have no impact on the residents other than potentially providing a sense of pride that their homes are being powered with clean renewable energy.

Pricing and Site-Specific Installation Notes to Contractor:

Blanco Apartments

Details regarding the roof replacement at Blanco Apartments are as follows. Note that all roof construction scope will need to be coordinated with the solar installation to preserve all specification requirements and full warranty terms.

Description

A. The Blanco Apartments Reroof is located at 906 W. Huisache, San Antonio, TX.

B. The project consists of installing a Thermoplastic Polyolefin Mechanically Attached Roofing System as outlined below:

   Apply the TPO Mechanically Attached Roofing System in conjunction with 3" polyiso insulation and ½" SecureRock after tearing off the existing built up roof and insulation to expose the

concrete deck for verification of suitable substrate, as specified in the Division 07 - ROOF REPLACEMENT specification**.**

C. Insulation should at minimum match current levels. The recommendation is for R-25, in line with current energy code.

Extent of Work

A. Provide all labor, material, tools, equipment, and supervision necessary to complete the installation of the .060" thick white reinforced TPO (Thermoplastic Polyolefin) membrane Mechanically Attached Roofing System, including flashings and insulation as specified in Division 07 – ROOF REPLACMENT and as indicated on the drawings in accordance with the manufacturer's most current specifications and details.

B. The roofing contractor shall be fully knowledgeable of all requirements of the contract documents and shall make themselves aware of all job site conditions that will affect their work.

C. The roofing contractor shall confirm all given information and advise the building owner, prior to bid, of any conflicts that will affect their cost proposal.

D. If there is intent to submit a bid using a roofing system other than the approved manufacturer, a detail description showing equivalency should be submitted. Bids that fail to detail all information as requested will be subject to rejection. Alternate bids stating "as per plans and specs" will be unacceptable.

Submittals

A. Prior to starting work, the roofing contractor must submit the following:

1. Shop drawings showing layout, details of construction and identification of materials.
2. Sample of the manufacturer's Membrane System Warranty.
3. Submit a letter of certification from the manufacturer which certifies the roofing contractor is authorized to install the manufacturer's roofing system and lists foremen who have received training from the manufacturer along with the dates training was received.
4. Certification from the membrane manufacturer indicating the fasteners are capable of providing a static backout resistance of 10 inch pounds minimum is required.
5. Certification from the membrane manufacturer indicating the membrane thickness over the reinforcing scrim (top ply membrane thickness) is nominal .015" (15 mil).
6. Certification of the manufacturer's warranty reserve.

B. Upon completion of the installed work, submit copies of the manufacturer's final inspection to the specifier prior to the issuance of the manufacturer's warranty.

Scope of Work

1. Prepare work area for installation of new roofing.
2. Tear off and dispose of existing built up roof and any insulation down to concrete deck.
3. Install new 1.5 density tapered EPS insulation system tapered to drains with a 1" start. 1/8" taper per foot.
4. Install a new ¼" SecureRock Hard Board.
5. Install new White 60mil TPO
6. Install new curbs and stack flashings.
7. Replace all metal caps, and metal edging as needed.

8. Install new walk-pad walkway from roof hatch to cooling tower and to other rooftop mounted equipment
9. Provide a 20 year Manufacturers full system warranty.

General Notes

Scope and pricing approach: This ECM requires a solar contractor(s) to provide a design assist approach where the solar contractor is required to provide a turnkey design, engineering, procurement, and construction (EPC) approach including:

Roof Top System

All required design, permitting, applications, and other requirements required by the jurisdiction having local authority as well as utility companies

Procurement and construction of the complete PV system

Interconnection

Required meters

Sizing: The systems should be designed and sized to offset as much of the load of the building as possible without the generation of additional electricity which would go back to the grid through net metering or a similar program (if applicable).

Warranty:

2 years materials and workmanship

Solar panel performance of 93 percent of nameplate at year 10 and 85 percent of nameplate at year 25 via pass through of module manufacturer warranty

20-year inverter warranty

Rebates / Incentives / Tax Credits: The solar contractor is to work with SAHA in maximizing and securing any utility rebates, renewable energy credits, and potentially monetizing any available tax credits.

Ownership Structure: Pricing and analysis for this ECM should assume SAHA owns the PV systems outright and there is no third party ownership or power purchase agreement ("PPA").

Operations and Maintenance: This ECM requires an annual O&M contract for 20 years where the solar contract is to provide pricing for such services.

Savings:

Site Name	Energy Conservation Measure (ECM) Description	Annualized First Year Energy Savings - Per Energy Audit									
		Water & Sewer			Electricity			Natural Gas			Total Energy Savings
		Gallons	Rate	($)	kWh	Rate	($)	ccf	Rate	($)	($)
Blanco	Solar Panels & New Roof	-	-	-	112,434	$ 0.09560	$ 10,749	-	-	-	$ 10,749

Calculation Methodology:

The "NREL PV Watts Modeling Software" (https://pvwatts.nrel.gov/pvwatts.php) was used to calculated solar savings. Details can be found in the "SAHA Phase II Savings Calculator".

Exhibit B

Project Specifications

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:
1. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
3. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Owner's and Construction Manager's responsive action.

B. Informational Submittals: Written and graphic information and physical samples that do not require Owner's and Construction Manager's responsive action. Submittals may be rejected for not complying with requirements.

1.3 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Owner, Commissioning Authority and Construction Manager and additional time for handling and reviewing submittals required by those corrections.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

a. Owner and Construction Manager reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Owner's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Owner will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.

C. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Owner and Construction Manager.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner**,** containing the following information:

a. Project name.
b. Date.
c. Name of Construction Manager.
d. Name of Contractor.
e. Name of firm or entity that prepared submittal.
f. Names of subcontractor, manufacturer, and supplier.
g. Category and type of submittal.
h. Submittal purpose and description.
i. Specification Section number and title.
j. Specification paragraph number or drawing designation and generic name for each of multiple items.
k. Location(s) where product is to be installed, as appropriate.
l. Related physical samples submitted directly.
m. Indication of full or partial submittal.
n. Transmittal number.
o. Submittal and transmittal distribution record.
p. Other necessary identification.

q. Remarks.

D. Options: Identify options requiring selection by Owner.

E. Deviations: Identify deviations from the minimum performance requirements on submittals.

F. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Owner's and Construction Manager's action stamp.

G. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

H. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Owner's and Construction Manager's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements:

1. Post electronic submittals as PDF electronic files directly to Project Web site specifically established for Project.

a. Owner, through Construction Manager, will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Or, submit electronic submittals via email as PDF electronic files.

a. Owner, through Construction Manager, will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

3. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

    a. Wiring diagrams showing factory-installed wiring.
    b. Printed performance curves.
    c. Operational range diagrams.
    d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:

    a. PDF electronic file.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the minimum performance specifications or standard printed data.

1. Preparation: Include the following information, as applicable:

    a. Identification of products.
    b. Schedules.
    c. Compliance with specified standards.
    d. Notation of coordination requirements.
    e. Notation of dimensions established by field measurement.
    f. Relationship and attachment to adjoining construction clearly indicated.
    g. Seal and signature of professional engineer, where required.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:

    a. PDF electronic file.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.
    b. Product name and name of manufacturer.
    c. Sample source.
    d. Number and title of applicable Specification Section.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Owner, through Construction Manager, will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three sets of Samples. Owner and Construction Manager will retain two Sample sets; remainder will be returned.

        1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Submit product schedule in the following format:

a. PDF electronic file.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are required of Contractor, provide products and systems complying with the minimum performance indicated.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract. Note corrections and field dimensions. Mark with approval stamp before submitting to Owner and Construction Manager.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved.

3.2 OWNER'S AND CONSTRUCTION MANAGER'S ACTION

A. General: Owner and Construction Manager will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Owner and Construction Manager will review each submittal, make marks to indicate corrections or revisions required, and return it. Owner and Construction Manager will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

C. Informational Submittals: Owner and Construction Manager will review each submittal and will not return it, or will return it if it does not comply with requirements. Owner and Construction Manager will forward each submittal to appropriate party.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
2. Requirements for Contractor to provide quality-assurance and -control services required by Owner, Commissioning Authority, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.
3. Specific test and inspection requirements are not specified in this Section.

1.2 DEFINITIONS

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

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements.

C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

F. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

G. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction. Additional, experience shall mean having at least three to five years' experience with like or similar in type, size projects and with credible references

1.3 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.

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

1.4 REPORTS AND DOCUMENTS

A. Quality Control Plan
1. Contractor to provide a plan that details the quality control process during submittals, equipment ordering, and installation
2. Quality control plan should ensure the equipment installed meets project specifications
3. Quality control plan should ensure that equipment is installed in correct location
4. Quality control plan should ensure that the quantity and location of installed equipment is tracked, and this information is provided to the owner and commissioning agent in a timely manner.
5. The quality control plan will not replace or substitute for any contractor quality control obligations outlined in the project commissioning specification.

B. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.

10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

C. Manufacturer's Field Reports: Prepare written information documenting tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.5 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Manufacturer's Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

H. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Owner or Commissioning Authority.
2. Notify Owner and Commissioning Authority seven days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Owner and Commissioning Authority approval of mockups before starting work, fabrication, or construction.

a. Allow seven days for initial review and each re-review of each mockup.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed unless otherwise indicated.

1.6 QUALITY CONTROL

A. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

B. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.

C. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the project requirements.

D. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Owner's, Commissioning Authority's, and Construction Manager's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Product maintenance manuals.
5. Systems and equipment maintenance manuals.

1.2 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Owner will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Owner.

    a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
    b. Enable inserted reviewer comments on draft submittals.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and no later than 30 days following receipt of approved contractor submittals. Owner and Commissioning Authority will return copy with comments.

1. Correct or revise each manual to comply with Owner's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Owner's and Commissioning Authority's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.

B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

C. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Commissioning Authority.
8. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
9. Cross-reference to related systems in other operation and maintenance manuals.

D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder. Highlight all installed model numbers. Provide an index of all project model numbers.

F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily

navigated file tree. Configure electronic manual to display bookmark panel on opening file.

G. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

   a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

   a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.3 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.

7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

F. Include name, phone numbers, and contact for the local reps who provided the equipment.

2.4 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures,

maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system. O&M Manuals are to be project specific and are not to include catalogs with multiple model numbers. All product data should be edited so as to provide only the information associated with the equipment provided on this project. All associated model numbers should be indexed and all non-relevant models shall be deleted. Include Name, phone numbers, and contact for the local reps who provided the equipment

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Utility, State, and Federal Incentives,

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
1. Number of Copies: Submit copies of record Drawings as follows:

a. Initial Submittal:
1) Submit PDF electronic files of scanned record prints and one set(s) of file prints.
2) Owner will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
3) Submit electronic copies of the piping schematic

b. Final Submittal:

1) Submit three paper-copy sets of marked-up record prints.
2) Three separate copies of record digital data file plots and editable electronic drawings (in an electronic format acceptable to the owner).
3) Central Plant Retrofit: Provide a framed, with glass, piping diagram/schematics securely affixed to the mechanical room wall in location determined by the Owner.
4) Central Plant Retrofit: Bind three copies of equipment product O&Ms, installing contractor contact list, manufacturer representative contact information, and a valve tag list in a metal binder that can be stored on the wall adjacent to the framed piping schematic.

B. Record Product Data: Submit two paper copies and annotated PDF electronic files and directories of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised Drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Record data as soon as possible after obtaining it.
c. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Owner and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
2. Format: DWG, Version , Microsoft Windows operating system. CONFIRM WITH OWNER PRIOR TO SUBMITTAL
3. Format: Annotated PDF electronic file with comment function enabled.
4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
5. Refer instances of uncertainty to Owner through Construction Manager for resolution.
6. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.

4. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Construction Manager.
    e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as annotated PDF electronic file.

2.4 Utility, State, and Federal Incentives

A. Preparation: Identify applicable utility, state and federal incentives associated with each installed energy and water conservation measure, and submit on behalf of the owner

1. Prepare all documentation required by incentive application
2. List the owner as incentive beneficiary
3. Maintain a log of all applications and cc correspondence with the owner.

2.5 MISCELLANEOUS RECORD SUBMITTALS

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

B. Format: Submit miscellaneous record submittals as PDF electronic file.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Owner's and Construction Manager's reference during normal working hours.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Demonstration and training video recordings.

1.2 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

1.3 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. At completion of training, submit complete training manual(s) for Owner's use prepared and bound in format matching operation and maintenance manuals and in PDF electronic file format on compact disc.

1.4 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations manuals.
    c. Maintenance manuals.
    d. Project record documents.
    e. Identification systems.
    f. Warranties and bonds.
    g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

3.2 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system. A manufacturer’s representative shall be present at a minimum of 1 training for each unique piece of equipment.

1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner's operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test.

F. A manufacturer’s representative will be present at all equipment training sessions.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. Provide digital video recordings of live training sessions for future use by owner and maintenance staff.

END OF SECTION 017900

SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Commissioning Plan prepared by the CxA contains requirements that apply to this Section.

1.2 SUMMARY

A. This Section includes general requirements that apply to implementation of commissioning without regard to specific systems, subsystems, and equipment being commissioned.

B. Owner has employed an independent Commissioning Authority (CxA). The Commissioning Authority is an independent and knowledgeable third party, hired to verify that the systems being commissioned work as intended. The Commissioning Authority will inform the Owner of the results of the Commissioning Process and provide suggestions, as necessary, to correct deficiencies in observed performance or installation.

C. The Commissioning Process is a quality-oriented process for achieving, verifying and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.

D. The Contractor is responsible for participation in the Commissioning Process as outlined in the Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections; the *Commissioning Plan.*

E. The *Commissioning Plan* provides specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

F. The Contractor is responsible to furnish labor and materials sufficient to meet all requirements of building commissioning under this contract.

1.3 SYSTEMS-TO-BE-COMMISSIONED

A. Central Plant Retrofits and Optimization

B. Solar PV

C. "Focused, Quality-Based Sampling" of Typical, Non Major ECMs
   1. In-unit Lighting Retrofits
   2. Heat Lamps
   3. Common Area Lighting Retrofit
   4. Exterior Lighting Retrofit

5. Exhaust Fans
6. Window Replacement
7. Furnaces
8. Heat Pumps
9. Low Flow Aerator Installations
10. Low Flow Showerhead Installations
11. Low Flow Water Closet Flush Valve Retrofits

D. There may be additional commissioning requirements in the San Antonio Housing Authority EPC Phase II Investment Grade Audit. All requirements and ECMs listed in the Audit apply to this project.

1.4 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Deficiency: Installation or remediation effort, or a portion thereof, that lacks in workmanship, quality and directly invalidates or compromises the energy performance of the energy conservation measure as identified in the *San Antonio Housing Authority EPC Phase II Investment Grade Audit*.
1. The Commissioning Authority and Owner shall be the sole authorities in determining what does or does not constitute as a deficiency in installation or remediation.

D. ECM: Energy Conservation Measure

E. Focused, Quality-Based Sampling: Commissioning effort intended to review a set percentage of typical installation and/or remediation efforts at a limited number of typical locations and types.

F. Functional Performance Testing (FPT): The testing of the dynamic function and operation of components, equipment and systems using manual (direct observation) and monitoring (data-logging/trending) methods.

G. Functional Performance Test procedure: A written protocol that defines methods, steps, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

H. Major Equipment Retrofits: Work associated with the Central Plant Retrofits & Optimization, Windows, and Roof Replacement with solar PV as identified and described in the *San Antonio Housing Authority EPC Phase II Investment Grade Audit*.

I. M&V: Measurement and Verification

J. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

K. Pre-Functional Checklist (PFC): A form used by the Contractor to verify that appropriate components are onsite, ready for installation, correctly installed, set up, calibrated and functional.

L. Quality Based Sampling: A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.

M. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

N. TAB: Testing, Adjusting and Balancing.

O. Typical, Non-Major: Energy Conservation Measures that require multiple installations or remediates executed in a typical fashion with each individual installation representing a non-major portion of a larger and major anticipated energy savings as described and identified in the *San Antonio Housing Authority EPC Phase II Investment Grade Audit*.

1.5 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
   1. Architect and engineering design professionals as required for complete implementation of ECMs.

B. Commissioning Coordinator Supervisor: The General Contractor shall provide a person with at least five (5) years of experience with the coordination of disciplines of construction. This person does not necessarily need to be fully dedicated to this role, but the Coordinator’s responsibilities shall, at a minimum, include:
   1. Cx Coordination meetings.
   2. Cx Planning.
   3. Cx Scheduling.
   4. Cx Documentation.
   5. Communication with the Commissioning Authority.
   6. Coordination and completion of Cx-related corrective actions.
   7. Owner Training.

C. Members Appointed by Owner:

   1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
   2. Representatives of the facility user and operation and maintenance personnel.

1.6 DOCUMENT SUBMISSION REQUIREMENTS

A. Provide a comprehensive submittal log of all submittals to the Commissioning Authority prior to submission of any equipment submittals for review.
   1. From the submittal log, the Commissioning Authority will identify which submittals shall be presented to the CxA for review and comment.
   2. The Commissioning Authority shall receive and review the submittals concurrent with the Owner.

B. Master Construction Schedule: Coordinate with the CxA the scheduling of the commissioning process with regards to timing and duration of the commissioning tasks and milestones. Including but not limited to, equipment start-up; testing, adjusting and balancing; functional performance testing and Owner training sessions.

C. Submit a copy of Construction Meeting Minutes; Requests for Information (RFI); Requests for Proposals (RFP) for construction, engineering and architectural services; Change Orders (CO); etc. to the CxA as they occur.

D. Submit training session plans to the CxA for approval after receiving the approved submittal for systems. See Part 3 below for training plan requirements. CxA will coordinate Owner approval of submitted training plans.

E. Contractor is required to submit the operation and maintenance manuals to the CxA and Owner for review within two (2) weeks after receiving the approved submittal for systems. Following review and approval process, submit final operations and maintenance manuals no later than two (2) weeks prior to the commencement of training.

F. Submit completed Pre-Functional and Startup Checklists to CxA within a minimum of one (1) week prior to scheduled Functional Performance Testing.

G. Submit Functional Performance Testing schedule to the CxA at least two (2) weeks prior to the start of testing.

H. Submit the Test and Balance Execution Plan to the Owner and CxA for review and approval no later two (2) weeks prior to the commencement of balancing.

I. Submit the completed preliminary test and balance reports to the Owner and CxA for review and approval within one (1) week of completion of work; and prior to commencement of HVAC system Functional Performance Tests. Legible, hand written, field generated test and balance reports are considered acceptable preliminary reports. Provide written documentation that all deficiency items identified in the preliminary test and balance report(s) have been addressed, or provide a schedule identifying when each item will be addressed. This shall include a schedule for when any additional testing, adjusting and balancing will be completed following corrective measures being completed.

J. System Functional Performance Testing will start only after the successful balance report is reviewed and accepted.

1.7 OWNER'S RESPONSIBILITIES

A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
   1. Coordination meetings.
   2. Making personnel available for training in operation and maintenance of systems, subsystems, and equipment.
   3. Testing meetings.
   4. Inspection and review of mock-ups and installations.
   5. Demonstration of operation of systems, subsystems, and equipment.

1.8 CONTRACTOR'S RESPONSIBILITIES

A. Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

   1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
   2. Cooperate with the CxA for resolution of issues recorded in the Issues and Benefits Log.
   3. Attend commissioning team meetings held on an as needed basis.
   4. Integrate and coordinate commissioning process activities with construction schedule.
   5. Review and accept pre-functional checklists provided by the CxA.
   6. Complete paper or electronic pre-functional checklists as Work is completed and provide to the Commissioning Authority prior to Functional Performance Testing.
   7. Review and accept commissioning functional performance test procedures provided by the Commissioning Authority.
   8. Complete commissioning functional performance test procedures.
   9. Provide to the CxA copies of all submittals and shop drawings, manufacturer's literature, maintenance information or other information as may be needed for systems to be commissioned.
   10. Provide the CxA with any requested documentation prior to, or in addition to, the O&M Manual submittals requirements outlined in other specification sections.
   11. Assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings, or equipment documentation is not sufficient for writing detailed functional performance testing procedures.
   12. Develop a full start-up and initial checkout plan using manufacturer’s start-up procedures and related specification sections.
   13. Provide updates to all project documentation to reflect all supplemental instructions, addenda or other modifications to the Contract Documents. Updates and supplemental instructions must be posted to the master set of Contract Documents for review and reference by all contractors, sub-contractors, and system component suppliers, and for the CxA's use.
   14. Provide qualified and trained personnel to participate in the commissioning process.
   15. Review the Cx Plan, Cx Issues and Benefits Logs, and project correspondence. In a timely manner, respond to the CxA and address the identified issues.
   16. Issue a written Notice of Readiness for each system to CxA upon completion of all systems work, start-up and Pre-functional Tests Checklists requirements by trade contractors.

17. Test all equipment and systems using the Functional Performance Test procedures *PRIOR TO DEMONSTRATING PROPER PERFORMANCE TO THE CXA*.
    a. Contractor is responsible for completing Functional Performance Testing. CxA is responsible for verifying Functional Performance Testing.
18. Operate equipment and systems as required for Functional Performance verification by CxA. This includes manipulating the temperature controls to execute the Functional Performance Test Procedures.
19. Participate in the fine-tuning or troubleshooting of system performance, if either of these measures becomes necessary.
20. Readiness
    a. It is the obligation of all parties to be prepared for commissioning activities. Prior to commencement of Functional Performance Testing the Contractor shall ensure completion of the following items as they relate to the equipment and/or system being commissioned:
        1) Permanent utility and central plant connection to the equipment/system.
        2) Completed equipment/system startup documentation has been delivered to the Commissioning Authority.
        3) Written notification from the responsible Contractor to the Commissioning Agent stating completion of equipment/system startup documentation
    b. It is at the sole discretion of the Commissioning Authority to begin Functional Performance Testing without one or more of the aforementioned items completed. If the aforementioned items will not be completed prior to the mutually agreed upon start date for Functional Performance Testing the Contractor may provide 48 hours notice. Failure of the Contractor to have the aforementioned items completed prior to the mutually agreed upon start date and failure to notify the Commissioning Authority within the aforementioned notification period will result in the Contractor being liable for all travel expenses incurred by Commissioning Agent which include all miles traveled and the time allocated for the Commissioning Authority to travel to and from the project site. Travel miles will be billed at the current year standard mileage rate as defined by the Internal Revenue Service. Hours for this travel will be billed at the nominal rate of $120 per hour.

1.9 CxA'S RESPONSIBILITIES

A. Organize and lead the Commissioning Team.

B. Provide and maintain Commissioning Plan.

C. Convene Cx team meetings and attend all appropriate meetings pertaining to Cx activities.

D. Provide project-specific construction pre-functional checklists and commissioning functional performance test procedures.

E. Verify the execution of commissioning process activities using focused, quality-based sampling. The sampling rate for typical, non-major installations and remediation is as defined in the Acceptance Procedures section of this specification. Verification will include, but is not limited to, equipment submittals, pre-functional checklists, training, operating and maintenance data, tests, and test reports. When a focused, quality-based sample does not meet the requirements of

the minimum performance specifications, the CxA will report the deficiency in the Issues and Benefits Log.

F. Prepare and maintain the Issues and Benefits Log.

G. Prepare and maintain completed construction pre-functional checklist log.

H. Witness systems, assemblies, equipment, and component startup.

I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide all tools, services and instruments required to test and adjust equipment and to verify compliance.

B. Provide calibration documentation, dated less than one (1) year of the date of use, for all tools and instruments used during functional performance testing.

PART 3 - EXECUTION

3.1 COORDINATION

A. Review the Commissioning Plan.

B. Attend all commissioning coordination meetings.

C. Include commissioning activities in the Master Construction Schedule.
   1. The master scheduling process will include the designation of contractor personnel required to perform the Function Performance Tests and coordination of deferred testing due to season, tenant fit-out schedule, etc.

3.2 TRAINING

A. Provide training for hardware and major components as specified within related sections and in the *Commissioning Plan*.

B. The Contractor is responsible for training coordination, scheduling and ensuring that training is completed per contract specifications.

C. The CxA shall help facilitate and oversee the training planning process for commissioned equipment and systems, however, all responsibility for providing training content and delivery is the Contractor's per the contract documents, including this specification section.

D. No later than two (2) weeks following acceptance of equipment and system submittals, the responsible Contractor will submit written training session plans to the CxA for review and approval. There shall be one session plan for each specification section requiring training. Each session plan will consider the following elements:
   1. Equipment/systems covered in each training session
   2. Intended audience
   3. Location of training
   4. Objectives
   5. Subjects covered (description, duration of discussion, special methods, etc.)
   6. Duration of training for each subject
   7. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
   8. Instructor and qualifications
   9. Option of three dates to hold the training session

E. The responsible Contractor works with the Commissioning Authority to develop an overall training plan (i.e., multiple training "sessions") for the commissioned systems.

F. The Contractors and vendors shall provide training. The Training Sessions provided by the responsible Contractors shall be customized for this project and reflect all the installed equipment and systems. Trainings of the materials, components, systems and equipment shall, at the minimum, incorporate the following items:
   1. Materials, components, systems and equipment
   2. Safety precautions and procedures.
   3. Installation.
   4. Operational features and functions.
   5. Operational testing and diagnostics.
   6. Preventive and predictive maintenance.
   7. Service: Repair and replacement.
   8. Operation and Maintenance manual content
   9. Testing, adjusting, calibration and balancing.
   10. Contractor furnished spare parts and extra materials.
   11. Recommended "attic stock" inventory not furnished by contractor.
   12. Specialty tool requirements.
   13. Lubricants
   14. Fuels.
   15. Identification systems.
   16. Automatic/manual control systems.
   17. Hazards/Material Safety Data Sheets
   18. Cleaning
   19. Procurement of replacement parts
   20. Warranty reviews including terms and conditions, points of contact, return material procedures, effective date, extended warranty options.
   21. Maintenance agreements and similar continuing commitments.

G. Obtain written acceptance of the training session from the Owner. CxA will coordinate Owner approval of submitted training plans.

H. At a minimum, document performance of each training session with a form including the following. Submit completed forms to the CxA through the GC no later than one (1) week following acceptable completion of the training session.

1. Date of training
2. Sign-in sheet of attendees and their affiliation
3. Sign-off (acceptance) by CxA and Owner

I. Comply with requirements as specified in other specification sections.

3.3 EQUIPMENT START-UP AND EQUIPMENT ENERGIZATION

A. The Contractor will inform CxA at least 48 hours in advance of the scheduled on-site start-up or equipment energization. CxA reserves the right to witness the performance of any or all start-up/energization procedures.

B. Conduct start-up and energization with authorized personnel who are factory-trained on the equipment being started. These personnel shall document the startup procedure, adjustments made, and results achieved. Record this information according to the startup checklist requirements provided by the associated equipment/system manufacturer.

C. Provide documented start-up reports to the CxA. Reports shall be complete, legible, dated, and signed by the factory trained and authorized representatives performing the associated work for the various systems being commissioned within one week of start-up.

D. Subcontractor/Installers shall forward to the CxA through the General Contractor a list and schedule of specified startup reports.

3.4 TESTING, ADJUSTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. The TAB contractor's test and balance engineer shall conduct a final inspection in the presence of Engineer and Commissioning Authority.
   1. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
   2. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   3. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
   4. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
      a. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

D. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

E. If any portion of this specification section contradicts or duplicates requirements found elsewhere in the Contract Documents, the more stringent requirements shall apply.

3.5 ACCEPTANCE PROCEDURES

A. Prior to functional performance testing of each system, the CxA will observe and verify that the physical installation of components and systems being tested is substantially installed in accordance with the minimum performance requirements of the project specifications and the *San Antonio Housing Authority EPC Phase II Investment Grade Audit*. As deemed necessary by the Owner and CxA, the CxA shall witness verification of operation for select typical, non-major installations and remediation as during observation and verification as part of the acceptance process. The number of observations and verifications will be approximately as follows:
   1. Major Equipment Retrofits: 100%
   2. Typical, Non-Major installations and remediation: Equipment mock-ups, and the greater of 2% or 30 installations and remediation for each typical, non-major installation and remediation measure type identified in the *Project Narrative*.
      a. For each ECM, if more than 10% of the Typical, Non-Major installations or remediation are found with deficiencies, then an additional 2% or 30 installations (a.k.a. second sampling group) shall be observed and verified. If more than 10% of the second sampling group is found with deficiencies, then an additional 10% of installations or remediation (a.k.a. third sampling group) will be observed and verified. If more than 5% of the third sampling group is found with deficiencies, then each and every installation or remediation from that specific ECM shall be observed and verified.
      b. If the initial focused, quality-based sampling for each ECM is found deficient, the Contractor shall be liable for all travel expenses and time incurred to observe and identify the second, third and fourth sampling groups for that ECM. Travel miles will be billed at the current year standard mileage rate as defined by the Internal Revenue Service. Hours will be billed at the nominal rate of $120 per hour.

B. Contractor's Tests:
   1. Check system for proper installation, and adjust and calibrate to verify that system is ready to function as specified.
   2. Check system elements to verify that they have been installed properly and that all connections have been made correctly.
   3. Adjust discrete elements and sub-systems and check for proper operation.

C. The Contractor shall provide technicians and installers as required by the CxA during observation and verification. Technicians and installers shall be knowledgeable on the installation or remediation and proficient on the equipment, components and systems being observed and verified.

3.6 FUNCTIONAL PERFORMANCE TESTS

A. Objective of these tests is to demonstrate that systems are operating and complying with specified performance requirements. In general, the procedures will test the following parameters:
   1. Operate each system through all modes of system, including individual interlocks and conditional control logic, all control sequences, both full-load and part-load conditions and simulation of all abnormal conditions for which there is a specified system or controls response.
   2. Impose temporary upsets of systems, such as distribution fault, control loss, setpoint change, equilibrium upset and component failure at different operation loads to determine system stability and recovery time.

B. The Contractor shall satisfactorily execute the Functional Performance Tests prior to the CxA witnessing and verifying the test execution.

C. Functional Performance Tests will be witnessed and endorsed by the CxA upon satisfactory completion. The CxA will recommend acceptance of the systems or identify deficiencies requiring correction and re-testing.

D. The final project specific Functional Performance Test procedures will be prepared by the CxA following Contract Award.

E. The Contractor shall review and comment on the Functional Performance Tests developed by the CxA based on approved equipment submittals and Operations & Maintenance manuals. Provide feedback as to the efficiency of the procedures and possible alternate approaches to achieving the same results.

F. Provide personnel and equipment as required to perform the Functional Performance Tests during CxA verification.

G. Verification of all Functional Performance Tests for each system shall be completed prior to occupancy or partial occupancy of the building.

H. For systems where only a sample of the equipment is subjected to a Functional Performance Test, the failing Functional Performance Test will be retested and an additional sample equal in size to the previous sample will be subjected to the Functional Performance Test.

I. Corrective Measures: If acceptable performance cannot be achieved, identify the cause of the deficiency. If it is determined that the deficiency was caused by the system or component not being installed according to manufacturer's recommendations or Contract Documents, make necessary corrections. Repeat every check or test for which acceptable performance was not achieved after the necessary corrective measures have been completed. Repeat re-testing process until acceptable performance is achieved. Contractor will be allowed one retest after initial testing of the equipment. If the retest fails, subsequent retests will be performed at the Installation Contractor’s expense.

3.7 CORRECTIVE ACTIONS

A. Perform corrective actions for resolution of deficiencies found during any step of the commissioning process.

B. For functional performance testing, a deficiency is defined as equipment that does not function as expected and more than five (5) minutes is required to correct the problem in the field during the testing verification.

C. The time and expense of the CxA to witness repeat Functional Performance Testing that is a result of a deficiency of corrective action resolution shall be considered as additional cost to the Owner. The total sum of such costs shall be deducted from the final payment to the Contractor.

3.8 OCCUPANCY AND WARRANTY PHASE COMMISSIONING

A. The Contractor and CxA will complete seasonal Functional Performance Testing in accordance with the Cx Plan and the above requirements of this specification section. In general, the season functional performance testing will require reconvening the Cx Team (Construction, CxA and Owner) to test system performance during the opposite season from the original functional performance testing (e.g. heating systems testing if systems originally tested during summer).
   1. The Contractor shall anticipate a total of 2 optimization efforts in addition to the initial functional performance testing and any re-testing for each central plant retrofit. The intent is to adjust setpoints, review operation and test system modification to achieve optimized performance. The Contractor shall provide skilled technicians or manufacturer’s personnel as needed to optimize the central plant operation.

B. The Contractor and CxA will review building operation approximately 8-10 months after the Date of Substantial Completion along with the Owner's operations and maintenance staff. The review will include reviewing any open items identified on the Cx Issues/Benefits Log, trend analysis results as completed by the CxA and any known or potential warranty items.

C. The Contractor and CxA will document a plan, if required, for resolution or correction of outstanding commissioning issues. The plan will identify each issue separately, with an agreed upon resolution; deadline for implementation of corrective measures; party or parties responsible for corrective measures and any criteria required for owner acceptance of the corrective measure.

END OF SECTION 019113

ROOF REPLACEMENT

Part 1 - GENERAL

1.01 Description

A. The project consists of installing a Thermoplastic Polyolefin Mechanically Attached Roofing System as outlined below:

1. Apply the TPO Mechanically Attached Roofing System in conjunction with 3" poly-iso insulation and ½" SecureRock after tearing off the existing Duro-Last roof and insulation to expose the concrete deck for verification of suitable substrate, as specified in this specification.

1.02 Extent of Work

A. Provide all labor, material, tools, equipment, and supervision necessary to complete the installation of the .060" thick white reinforced TPO (Thermoplastic Polyolefin) membrane Mechanically Attached Roofing System, including flashings and insulation as specified herein and as indicated on the drawings in accordance with the manufacturer's most current specifications and details.

B. The roofing contractor shall be fully knowledgeable of all requirements of the contract documents and shall make themselves aware of all job site conditions that will affect their work.

C. The roofing contractor shall confirm all given information and advise the building owner, prior to bid, of any conflicts that will affect their cost proposal.

D. If there is intent to submit a bid using a roofing system other than the approved manufacturer, a detail description showing equivalency should be submitted. Bids that fail to detail all information as requested will be subject to rejection. Alternate bids stating "as per plans and specs" will be unacceptable.

1.03 Submittals

A. Prior to starting work, the roofing contractor must submit the following:

1. Shop drawings showing layout, details of construction, and identification of materials.

2. Sample of the manufacturer's Membrane System Warranty.

3. Submit a letter of certification from the manufacturer which certifies the roofing contractor is authorized to install the manufacturer's roofing system and lists foremen who have received training from the manufacturer along with the dates training was received.

4. Certification from the membrane manufacturer indicating the fasteners are capable of providing a static backout resistance of 10 inch pounds minimum is required.

5. Certification from the membrane manufacturer indicating the membrane thickness over the reinforcing scrim (top ply membrane thickness) is nominal .015" (15 mil).

6. Certification of the manufacturer's warranty reserve.

B. Upon completion of the installed work, submit copies of the manufacturer's final inspection to the specifier prior to the issuance of the manufacturer's warranty.

1.04 Product Delivery, Storage, and Handling

A. Deliver materials to the job site in the manufacturer’s original, unopened containers or wrappings with the manufacturer's name, brand name and installation instructions intact and legible. Deliver in sufficient quantity to permit work to continue without interruption.

B. Comply with the manufacturer's written instructions for proper material storage.

1. Store TPO membrane in the original undisturbed plastic wrap in a cool, shaded area and cover with light-colored, breathable, waterproof tarpaulins. TPO membrane that has been exposed to the elements for approximately 7 days must be prepared with TPO Weathered Membrane Cleaner prior to hot air welding.

2. Store curable materials (adhesives and sealants) between 60°F and 80°F in dry areas protected from water and direct sunlight. If exposed to lower temperature, restore to 60°F minimum temperature before using.

3. Store materials containing solvents in dry, well ventilated spaces with proper fire and safety precautions. Keep lids on tight. Use before expiration of their shelf life.

C. Insulation must be on pallets, off the ground and tightly covered with waterproof materials.

D. Any materials which are found to be damaged shall be removed and replaced at the Contractor's expense.

1.05 Work Sequence

A. Schedule and execute work to prevent leaks and excessive traffic on completed roof sections. Care should be exercised to provide protection for the interior of the building and to ensure water does not flow beneath any completed sections of the membrane system.

B. Do not disrupt activities in occupied spaces.

1.06 Use of the Premises

A. Before beginning work, the roofing contractor must secure approval from the building owner’s representative for the following:

1. Areas permitted for personnel parking.

2. Access to the site.

3. Areas permitted for storage of materials and debris.

4. Areas permitted for the location of cranes, hoists, and chutes for loading and unloading materials to and from the roof.

B. Interior stairs or elevators may not be used for removing debris or delivering materials, except as authorized by the building superintendent.

1.07 Existing Conditions

If discrepancies are discovered between the existing conditions and those noted in the measure narrative or specifications, immediately notify the owner's representative by phone and solicit the manufacturer's approval prior to commencing with the work. Necessary steps shall be taken to make the building watertight until the discrepancies are resolved.

1.08 Pre-Construction

A. Prior to bid submittal, the roofing contractor should schedule a job site inspection to observe actual conditions and verify all dimensions on the roof.

B. Any conditions which are not shown on the shop drawings should be indicated on a copy of the shop drawing and included with bid submittal if necessary to clarify any conditions not shown.

1.09 Temporary Facilities and Controls

A. Temporary Utilities:

1. Water, power for construction purposes, and lighting are available at the site and will be made available to the roofing contractor.

2. Provide all hoses, valves and connections for water from source designated by the owner when made available.

3. When available, electrical power should be extended as required from the source. Provide all trailers, connections and fused disconnects.

B. Temporary Sanitary Facilities

Sanitary facilities will not be available at the job site. The roofing contractor shall be responsible for the provision and maintenance of portable toilets or their equal.

C. Building Site

1. The roofing contractor shall use reasonable care and responsibility to protect the building and site against damages. The contractor shall be responsible for the correction of any damage incurred as a result of the performance of the contract.

2. The roofing contractor shall remove all debris from the job site in a timely and legally acceptable manner so as to not detract from the aesthetics or the functions of the building.

D. Security

Obey the owner's requirements for personnel identification, inspection and other security measures.

1.10 Job Site Protection

A. The roofing contractor shall adequately protect building, paved areas, service drives, lawn, shrubs, trees, etc. from damage while performing the required work. Provide canvas, boards and sheet metal (properly secured) as necessary for protection and remove protection material at completion. The contractor shall repair or be responsible for costs to repair all property damaged during the roofing application.

B. During the roofing contractor's performance of the work, the building owner will continue to occupy the existing building. The contractor shall take precautions to prevent the spread of dust and debris, particularly where such material may sift into the building. The roofing contractor shall provide labor and materials to construct, maintain and remove necessary temporary enclosures to prevent dust or debris in the construction area(s) from entering the remainder of the building.

C. Do not overload any portion of the building, either by use of or placement of equipment, storage of debris, or storage of materials.

D. Protect against fire and flame spread. Maintain proper and adequate fire extinguishers.

E. Take precautions to prevent drains from clogging during the roofing application. Remove debris at the completion of each day's work and clean drains, if required. At completion, test drains to ensure the system is free running and drains are watertight. Remove strainers and plug drains in areas **where work is in progress**. Install flags or other telltales on plugs. Remove plugs each night and screen drain.

F. Store moisture-susceptible materials above ground and protect with waterproof coverings.

G. Remove all traces of piled bulk materials and return the job site to its original condition upon completion of the work.

1.11 Safety

The roofing contractor shall be responsible for all means and methods as they relate to safety and shall comply with all applicable local, state and federal requirements that are safety related. Safety shall be the responsibility of the roofing contractor. All related personnel shall be instructed daily to be mindful of the full time requirement to maintain a safe environment for the facility’s occupants including staff, visitors, customers and the occurrence of the general public on or near the site.

1.12 Workmanship

A. Contractors installing new roof, flashing and related work shall be factory trained and approved by the manufacturer they are representing.

B. All work shall be of highest quality and in strict accordance with the manufacturer's published specifications and to the building owner's satisfaction.

C. There shall be a supervisor on the job site at all times while work is in progress.

1.13 Quality Assurance

A. The TPO membrane roofing system must achieve a UL Class A and a 72 MPH wind rating.

B. Unless otherwise noted in this specification, the roofing contractor must strictly comply with the manufacturer's current specifications and details.

C. The roofing system must be installed by a contractor authorized and trained by the manufacturer in compliance with shop drawings as approved by the manufacturer.

D. Provide adequate number of experienced workmen regularly engaged in this type of work who are skilled in the application techniques of the materials specified. Provide at least one thoroughly trained and experienced superintendent on the job at all times roofing work is in progress.

E. There shall be no deviations made from this specification or the approved shop drawings without the prior written approval of the specifier. Any deviation from the manufacturer's installation procedures must be supported by a written certification on the manufacturer's letterhead and presented for the specifier's consideration.

F. Upon completion of the installation, the Contractor shall arrange for an inspection to be made by a non-sales technical representative of the membrane manufacturer in order to determine whether or not corrective work will be required before the warranty will be issued. Notify the building owner seventy-two (72) hours prior to the manufacturer's final inspection.

1.14 Job Conditions, Cautions, and Warnings

A. Material Safety Data Sheets (MSDS) must be on location at all times during the transportation, storage and application of materials.

B. When positioning membrane sheets, exercise care to locate all field splices away from low spots and out of drain sumps. All field splices should be shingled to prevent bucking of water.

C. When loading materials onto the roof, the TPO Authorized Roofing Contractor must comply with the requirements of the building owner to prevent overloading and possible disturbance to the building structure.

D. Proceed with roofing work only when weather conditions are in compliance with the manufacturer's recommended limitations, and when conditions will permit the work to proceed in accordance with the manufacturer's requirements and recommendations.

E. Proceed with work so new roofing materials are not subject to construction traffic. When necessary, new roof sections shall be protected and inspected upon completion for possible damage.

F. Provide protection, such as 3/4 inch thick plywood, for all roof areas exposed to traffic during construction. Plywood must be smooth and free of fasteners and splinters.

G. The surface on which the insulation or roofing membrane is to be applied shall be clean, smooth, dry, and free of projections or contaminants that would prevent proper application of or be incompatible with the new installation, such as fins, sharp edges, foreign materials, oil and grease.

H. New roofing shall be complete and weather-tight at the end of the work day.

I. Contaminants such as grease, fats and oils shall not be allowed to come in direct contact with the roofing membrane.

1.15 Warranty

A. Provide manufacturer's 20 year Total System Warranty covering both labor and material with no dollar limitation. The maximum wind speed coverage shall be peak gusts of 72 MPH measured at 10 meters above ground level. Certification is required with bid submittal indicating the manufacturer has reviewed and agreed to such wind coverage.

B. Pro-rated System Warranties shall not be accepted.

C. Evidence of the manufacturer's warranty reserve shall be included as part of the project submittals for the specifier's approval.

Part 2 - PRODUCTS

2.01 General

All products (including insulation, fasteners, fastening plates and edgings) must be manufactured and supplied by the roofing system manufacturer and covered by the warranty.

2.02 Membrane

Furnish TPO .060" thick white reinforced TPO (Thermoplastic Polyolefin) membrane as needed to complete the roofing system. Membrane thickness over the reinforcing scrim (top-ply thickness) shall be nominal .015" thick (15 mil).

2.03 Insulation/Underlayment

A. When applicable, insulation shall be installed in multiple layers. The first and second layer of insulation shall be mechanically attached to the substrate in accordance with the manufacturer's published specifications.

B. Insulation shall be poly-iso as supplied by TPO manufacture. Minimum R-value required is R-25.

C. SecureRock Cover Board - A uniform composition of fiber-reinforced with no facer for use as a cover board. Available in ½” and 4' x 8' size boards.

2.04 Adhesives and Cleaners

All products shall be furnished by roofing manufacturer and specifically formulated for the intended purpose.

A. Bonding Adhesive:

B. Edge Sealant: Cut Edge Sealant

C. Sealer: Water Cut-Off Mastic and PT 304 Sealant

D. Pocket Sealant: TPO Molded Pocket Sealant

E. Cleaner: PO Membrane cleaner

2.05 Fasteners and Plates

To be used for mechanical attachment of insulation and to provide additional membrane securement:

A. **CD-10 Fasteners:** A non-threaded, hammer driven fastener used with structural concrete roof decks rated 3,000 psi or greater.

B. **MP-14-10 Fasteners:** A #14 threaded fastener used for minimum 3,000 psi concrete decks.

C. **HP Term Bar Nail-Ins:** A 1-1/4" long expansion anchor with a zinc plated steel drive pin used for fastening the TPO Termination Bar or Seam Fastening Plates to concrete, brick, or block walls.

D. **HPVX Plates:** A 2-3/8” diameter metal barbed fastening plate used with TPO Fasteners for membrane securement. This plate can be used for insulation securement.

2.06 Metal Edging and Membrane Terminations

A. **Termination Bar:** a 1 inch wide and .098 inch thick extruded aluminum bar pre-punched 6 inches on center; incorporates a sealant ledge to support Lap Sealant and provide increased stability for membrane terminations.

B. **Metal Wall Flashing:** a 24 gauge galvanized nail in wall reglet should be used to cover up membrane termination bar.

Part 3 - EXECUTION

3.01 General

A. Comply with the manufacturer's published instructions for the installation of the membrane roofing system including proper substrate preparation, jobsite considerations and weather restrictions.

B. Position sheets to accommodate contours of the roof deck and shingle splices to avoid bucking water.

3.02 Insulation Placement and Attachment

A. Install insulation or membrane underlayment over the substrate with boards butted tightly together with no joints or gaps greater than 1/4 inch. Stagger joints both horizontally and vertically if multiple layers are provided.

B. Secure insulation to the substrate with the required TPO fasteners and plates in accordance with manufacturers specifications.

3.03 Membrane Placement and Attachment

A. Unroll and position membrane without stretching. Provide and secure both perimeter and field membrane sheets in accordance with the manufacturer's most current specifications and details.

B. Secure the membrane with the required manufacture Fasteners and Plates spaced a maximum of 12 inches on center depending or project conditions (centered over the pre-printed marks approximately 1- 1/2 inches from the edge of the membrane sheet).

C. Install adjoining membrane sheets in the same manner in accordance with the manufacturer's specifications.

3.04 Membrane Splicing/Hot Air Welding Procedures

A. Hot air weld the TPO membrane using an Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer’s specifications. At all splice intersections, roll the seam with a silicone roller prior to membrane seam cooling. When using .060" thick membrane, all splice intersections shall be overlaid with TPO non-reinforced flashing.

B. Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes).

C. Repair all seam deficiencies the same day they are discovered.

D. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim reinforcement is exposed) after seam probing is complete.

3.05 Flashing

A. Flashing of parapets, curbs, expansion joints and other parts of the roof must be performed using TPO reinforced membrane. TPO non-reinforced membrane can be used for flashing pipe penetrations, Sealant Pockets, scuppers, as well as inside and outside corners when the use of pre-fabricated accessories is not feasible.

B. Follow manufacturer's typical flashing procedures for all wall, curb, and penetration flashing including metal edging/coping and roof drain applications.

3.06 Walkways

A. Install walkways at all traffic concentration points (such as roof hatches, access doors, rooftop ladders, etc.) and all locations as identified on the specifier's drawing.

B. Hot air weld walkway pads, in accordance with the manufacturer's specifications.

3.07 Daily Seal

A. On phased roofing, when the completion of flashings and terminations is not achieved by the end of the work day, a daily seal must be performed to temporarily close the membrane to prevent water infiltration.

B. Complete an acceptable membrane seal in accordance with the manufacturer's requirements.

3.08 Clean Up

A. Perform daily clean-up to collect all wrappings, empty containers, paper, and other debris from the project site. Upon completion, all debris must be disposed of in a legally acceptable manner.

B. Prior to the manufacturer's inspection for warranty, the Contractor must perform a pre-inspection to review all work and to verify all flashing has been completed as well as the application of all caulking.

END OF SPECIFICATION

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. All exterior windows furnished and installed, specified in this section and designated in AAMA 101 and 101/I.S.-2.
2. All labor, materials, tools, equipment and services needed to furnish and install Architectural Performance Class windows. (Structural requirements of windows in this high-rise application need to be confirmed by a structural engineer.)
3. Components furnished with installed windows.
4. Installation accessories furnished and installed.

1.02 SYSTEM PERFORMANCE REQUIREMENTS

A. Design Wind Loads

1. The design wind pressure for the project will be: (To be determined by structural engineer)
    a. ___ psf positive and negative; ___ psf negative at corner zones
    b. Per wind pressure diagram
    c. Per local building codes
2. All structural components, including meeting rails, mullions and anchors shall be designed accordingly, complying with deflection and stress requirements of Paragraph 1.02.B.

[Determination of Design Load(s) is the sole responsibility of the building's Engineer of Record, considering Code interpretation issues and/or prescriptive requirements not included in Contract Documents.]

B. Air, Water and Structural Performance Requirements

1. When tested in accordance with cited test procedures, windows shall meet or exceed the following performance criteria, as well as those indicated in AAMA 101 and 101/I.S.-2 for Architectural AW Performance Class windows, Performance Grade 40 (AW40) unless otherwise noted herein (to be confirmed by structural engineer).
2. Air Test Performance Requirements
    a. Air infiltration maximum 0.3 cfm per square foot at 6.24 psf pressure differential when tested in accord with ASTM E283.
3. Water Test Performance Requirements
    a. Two mock-ups shall be tested in accordance with ASTM E 1105.

b. No uncontrolled water leakage at 12.00 psf static pressure differential, with water application rate of 5 gallons/hr/sq ft when tested in accord with ASTM E331.

4. Structural Test Performance Requirements

a. Uniform Load Deflection Test

1. No deflection of any unsupported span L of test unit (framing rails, muntins, mullions, etc.) in excess of L/175 at both a positive and negative load of 60 psf (design test pressure) when tested in accord with ASTM E330.

2. If structural reinforcing is used on test units, it must be provided on project units requiring similar I-value.

b. Uniform Load Structural Test

1. Unit to be tested at 1.5 x design test pressure, both positive and negative, acting normal to plane of wall in accord with ASTM E330.

2. No glass breakage; permanent damage to fasteners, hardware parts, or anchors; damage to make windows inoperable; or permanent deformation of any main frame or ventilator member in excess of 0.2% of its clear span.

C. Energy Performance

1. Thermal transmittance (U-Factor) rating in accordance with NFRC 100.

a. U-Factor shall not exceed 0.32 BTU/hr/sf/deg F

2. Solar Heat Gain Coefficient and Visible Transmittance ratings in accordance with NFRC 200.

a. Solar Heat Gain Coefficient shall not exceed 0.25

b. Visible Transmittance rating shall not be less than 0.60

3. Condensation Resistance Factor (CRF) requirements: CRF minimum 52 (Frame) and CRF minimum 66 (Glass).

D. Compliance with Local Historic Building Standards

1. Selected windows must meet all relevant codes and standards of the Authority Having Jurisdiction, including those for historic buildings.

1.03 SUBMITTALS

A. General Requirements

1. Provide all submittals in a timely manner to meet the required construction completion schedule.

B. Shop Drawings

1. Shop drawings must be prepared wholly by the window manufacturer, or a qualified engineering services firm under the direction of the manufacturer. Shop drawings for pre-engineered configurations may be prepared by installers authorized per 1.04 QUALITY ASSURANCE.
2. Provide design details along with bid proposals to define system aesthetic and functional characteristics.
3. Provide three photocopied sets of shop drawings, including half size details of all necessary conditions.

C. Samples

1. Components: Submit samples of anchors, fasteners, hardware, assembled corner sections and other materials and components as requested by Architect.
2. Finish: Submit color samples for Architect's approval as requested.

D. Test Reports and Calculations

1. Submit certified independent laboratory test reports verifying compliance with all test requirements of 1.02 SYSTEM.
2. Submit structural calculations prepared by a Registered Structural Engineer indicating adequacy of all materials furnished under this section, to meet the uniform and structural load requirements as specified in 1.02.A SYSTEM.

1.04 QUALITY ASSURANCE

A. Qualifications: Upon request, the window manufacturer will provide written confirmation that the installer is authorized to install window products to be used on this project.

B. In-Plant Testing: Conduct ASTM air and static water infiltration testing on a minimum of 1% of factory-glazed windows prior to shipping, subject to reasonable size restrictions. Each tested unit shall be identified with a removable sticker on the inside glass face. Provide detailed documentation of in-plant testing upon request.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading

1. Materials will be packed, loaded, shipped, unloaded, stored and protected in accordance with AAMA CW-10.

1.06 WARRANTY

A. Window Warranty

1. Products: Submit a written warranty, executed by the window manufacturer, for a period of 10 years from the date of manufacture, against defective materials or workmanship, including substantial non-compliance with applicable specification requirements and industry standards, which results in premature failure of the windows, finish, factory-glazed glass, or parts, outside of normal wear.
    a. In the event that windows or components are found defective, manufacturer will repair or provide replacements without charge at manufacturer's option.
    b. Warranty for all components must be direct from the manufacturer (non pass-through) and non pro-rated for the entire term. Warranty must be assignable to the non-residential owner, and transferable to subsequent owners though its length.
2. Installation: Submit a written warranty, executed by the window installer, for a period of 3 years from the date of substantial completion, against defective materials or workmanship, including substantial non-compliance with applicable specification requirements, which result in premature failure.
    a. In the event that installation of windows or components is found to be defective, installer will repair or provide replacements without charge at the installer's option.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer

B. Replacement windows shall be flush fin replacement windows allowing the existing window frame to be left in place and concealed. The owner preference is for Milgard manufactured windows with Z-Bar installation. Alternative products must be approved by the owner.

2.02 MINIMUM HUD PROPERTY STANDARDS

A. Products shall meet or exceed HUD Minimum Property Standards, as well as State and Local Codes for all testing requirements

PART 3 - EXECUTION

3.01 EXAMINATION

A. Site Verification of Conditions

1. Verify existing conditions and perform window take-offs to determine appropriate window sizes. Include all windows on project.
2. Verify that building substrates permit installation of windows according to the manufacturer's instructions, approved shop drawings, calculations and contract documents.
3. Do not install windows until unsatisfactory conditions are corrected.

3.02 DEMOLITION

A. Demolition of Existing Windows

1. Schedule and phase window demolition and installation to minimize disruption to tenants.
2. Provide protection to interior and exterior surroundings to ensure safety of occupants and avoid damage to interior and exterior of building.
3. Remove existing windows.
4. Remove all demolition debris. Recycle metal window frames. Installer shall provide receipts from recycling center to verify that removed window frames were recycled.

3.03 INSTALLATION

A. Erection of Windows

1. Install windows with skilled tradesman in exact accordance with approved shop drawings, installation instructions, specifications, and AAMA101 and 101/I.S.-2.
2. Windows must be installed plumb, square and level for proper weathering and operation.
3. Return elements of construction and surfaces that are to remain to the conditions existing before demolition began.

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

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

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.
5. Electronically Commutated.
6. Unless otherwise noted.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type or electronically commutated.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220513

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber union connector packless expansion joints.
2. Flexible-hose packless expansion joints.
3. Externally pressurized metal-bellows packless expansion joints.
4. Alignment guides and anchors.
5. Pipe loops and swing connections.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

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

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

A. Rubber Union Connector Expansion Joints:
1. Material: Twin reinforced-rubber spheres.
2. Minimum Pressure Rating: 150 psig at 170 deg F (1035 kPa at 77 deg C), unless otherwise indicated.
3. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

B. Flexible-Hose Packless Expansion Joints:
Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
1. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
2. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.

a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.

3. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.

4. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.

5. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon-steel fittings with end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.

C. Externally Pressurized Metal-Bellows Packless Expansion Joints:

1. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
2. Description:

    a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
    b. Carbon-steel housing.
    c. Drain plugs and lifting lug for NPS 3 (DN 80) and larger.
    d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
    e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
    f. Joint Axial Movement: 4 inches (100 mm) of compression and 0.75 inch (19 mm) of extension.

3. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
4. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Stud: Threaded, zinc-coated carbon steel.
    b. Expansion Plug: Zinc-coated steel.
    c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
    c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 220516

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION 220517

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Standard: ASME B40.200.

B. Accuracy: Plus or minus 1.5 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Type: Stepped shank unless straight or tapered shank is indicated.
4. Bore: Diameter required to match thermometer bulb or stem.
5. Insertion Length: Length required to match thermometer bulb or stem.
6. Lagging Extension: Include on thermowells for insulated piping and tubing.
7. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
3. Movement: Mechanical, with link to pressure element and connection to pointer.
4. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
5. Pointer: Dark-colored metal.

B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
3. Movement: Mechanical, with link to pressure element and connection to pointer.
4. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi Pointer: Dark-colored metal.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Movement: Mechanical, with link to pressure element and connection to pointer.
3. psi
4. Pointer: Dark-colored metal.

D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Movement: Mechanical, with link to pressure element and connection to pointer.
2. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
3. Pointer: Dark-colored metal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.

K. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

L. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

M. Adjust faces of meters and gages to proper angle for best visibility.

3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

D. Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

E. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

B. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

3.4 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi and 0 to 600 kPa.

B. Scale Range for Domestic Water Piping: 0 to 100 psi and 0 to 600 kPa.

END OF SECTION 220519

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze swing check valves.
2. Iron swing check valves.
3. Iron swing check valves with closure control.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

2.3 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
1. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE.
j. Gasket: Asbestos free.

2.4 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
1. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:
1. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed exterior lever and weight.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; metal-seat or resilient-seat check valves.
c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded or soldered.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Bronze swing check valves, Class 125, bronze disc with soldered or threaded end connections.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron swing check valves, Class 125, metal seats with threaded or flanged end connections.
2. Iron swing check valves with closure control, Class 125, lever and spring weight with threaded or flanged end connections.

END OF SECTION 220523.14

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer.

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.6 EQUIPMENT SUPPORTS

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

2.7 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch (0.8-mm) stainless steel, 0.025-inch (0.64-mm) aluminum, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
4. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

D. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover 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; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

PART 3 - EXECUTION

3.1 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.2 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Domestic Water Piping

a. Background: Safety green.
b. Letter Colors: White.

END OF SECTION 220553

SECTION 220716 - PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing equipment:

1. Domestic water heat exchangers.
2. Domestic water converters.

B. Related Sections:

1. Section 220719 "Plumbing Piping Insulation."

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail removable insulation at equipment connections and access panels.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.
6. Detail field application for each equipment type.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

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

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

F. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, use adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   4. Color: White.
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   4. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   5. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. See Section 016000 "Product Requirements."

   6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
   7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for equipment.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated tank heads and tank side panels.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.

5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches (75 mm).
2. Adhesive Thickness: 1.5 mils (0.04 mm).
3. Elongation at Break: 145 percent.
4. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
b. Spindle: fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

b. Spindle: fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
c. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

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

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable

between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches (75 mm).
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.4 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll

allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.6 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

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

3.8 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heat-Exchanger (Water-to-Water for Domestic Water Heating Service) Insulation:

1. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

D. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
3. Polyolefin: 1 inch (25 mm) thick.

E. Domestic Hot-Water Storage Tank Insulation:

1. Mineral-Fiber Pipe and Tank: Of thickness to provide an R-value of 12.5.

F. Domestic Water Filter-Housing Insulation:

1. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

3.9 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.

D. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. None.
2. PVC: 20 mils (0.5 mm) thick.

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. If more than one material is listed, selection from materials listed is Contractor's option.

B. Equipment, Concealed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.

END OF SECTION 220716

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic hot-water piping.
2. Domestic recirculating hot-water piping.
3. Sanitary waste piping exposed to freezing conditions.
4. Storm-water piping exposed to freezing conditions.
5. Roof drains and rainwater leaders.
6. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 220716 "Plumbing Equipment Insulation."

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

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

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Special-Shaped Insulation: ASTM C 552, Type III.
2. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
3. Preformed Pipe Insulation with Factory-Applied ASJ or ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A,. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Finish and thickness are indicated in field-applied jacket schedules.
2. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper or 2.5-mil- (0.063-mm-) thick polysurlyn.
3. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper or 2.5-mil- (0.063-mm-) thick polysurlyn.
4. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Tee covers.
    d. Flange and union covers.
    e. End caps.
    f. Beveled collars.
    g. Valve covers.
    h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).

3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

2.11 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers, Insert drawing designation:
1. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures,:
1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

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

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable

insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.

3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.10 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

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

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

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:

1. Flexible Elastomeric: 3/4 inch (19 mm) thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
3. Polyolefin: 3/4 inch (19 mm) thick.

B. Stormwater and Overflow: Insulation shall be the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
3. Polyolefin: 1 inch (25 mm) thick.

C. Roof Drain and Overflow Drain Bodies: Insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
3. Polyolefin: 1 inch (25 mm) thick.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:

1. Flexible Elastomeric: 1/2 inch (13 mm) thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
3. Polyolefin: 1/2 inch (13 mm) thick.

E. Sanitary Waste Piping Where Heat Tracing Is Installed: Mineral-fiber, preformed pipe insulation, Type I, 1-1/2 inches (38 mm) thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping: Insulation shall be one of the following:

1. Cellular Glass: 2 inches (50 mm) thick.
2. Flexible Elastomeric: 2 inches (50 mm) thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
4. Polyolefin: 2 inches (50 mm) thick.

B. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:

1. Cellular Glass: 2 inches (50 mm) thick.
2. Flexible Elastomeric: 2 inches (50 mm) thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
4. Polyolefin: 2 inches (50 mm) thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed: Insulation shall be one of the following:

1. Cellular Glass: 2 inches (50 mm) thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

3.15 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches (50 mm) thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.
3. Aluminum,: 0.016 inch (0.41 mm) thick.

D. Piping, Exposed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.
3. Aluminum,: 0.016 inch (0.41 mm) thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. PVC: 20 mils (0.5 mm) thick.
2. Aluminum,: 0.016 inch (0.41 mm) thick.

D. Piping, Exposed:

1. PVC: 20 mils (0.5 mm) thick.
2. Aluminum,: 0.016 inch (0.41 mm) thick.

3.18 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

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

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

B. Related Requirements:

1. Section 221113 "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.2 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:

1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:

1. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
2. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. Not permitted. All accessible piping to be replaced where in the scope of work for this project.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. Not permitted. All accessible piping to be replaced where in the scope of work for this project.

2.5 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.6 PEX TUBE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.7 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.

B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.

C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.8 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. 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).
3. 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."

G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

1. 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).
2. 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).
3. 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."

H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.9 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

1. Description:

a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

D. Plastic-to-Metal Transition Unions:

1. Description:

a. CPVC or PVC four-part union.
b. Brass threaded end.
c. Solvent-cement-joint plastic end.
d. Rubber O-ring.
e. Union nut.

2.10 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Standard: ASSE 1079.

2. Pressure Rating: 125 psig minimum at 180 deg F.
3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Standard: ASSE 1079.
2. Factory-fabricated, bolted, companion-flange assembly.
3. Pressure Rating: 125 psig minimum at 180 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Nonconducting materials for field assembly of companion flanges.
2. Pressure Rating: 150 psig.
3. Gasket: Neoprene or phenolic.
4. Bolt Sleeves: Phenolic or polyethylene.
5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F 1545.
3. Pressure Rating and Temperature: 300 psig at 225 deg F.
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure

gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

G. Install domestic water piping level and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install PEX piping with loop at each change of direction of more than 90 degrees.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

T. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.

I. Joints for PEX Piping: Join according to ASTM F 1807.

J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.

3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
5. NPS 6: 48 inches with 3/4-inch rod.
6. NPS 8: 48 inches with 7/8-inch rod.

J. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

K. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.

L. Install hangers for vertical PEX piping every 48 inches.

M. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8: 48 inches with 7/8-inch rod.

N. Install supports for vertical PVC piping every 48 inches.

O. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K; joints.
2. PVC, Schedule 40 Schedule 80; socket fittings; and solvent-cemented joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
3. PVC, Schedule 40; socket fittings; and solvent-cemented joints.

F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be the following:

1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard or soft copper tube, ASTM B 88, Type L;
2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

H. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
2. Hard copper tube, ASTM B 88, Type L;
3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
4. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper push-on-joint fittings; and push-on joints.
5. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints.
8. PEX tube, NPS 1 and smaller; fittings for PEX tube; and crimped joints.
9. PVC, Schedule 40; socket fittings; and solvent-cemented joints.

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings.
2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved-joint, copper-tube appurtenances; and grooved joints.
4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
5. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. PVC, Schedule 40; socket fittings; and solvent-cemented joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings.
2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved-joint, copper-tube appurtenances; and grooved joints.
3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
4. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.

5. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
6. PVC, Schedule 40; socket fittings; and solvent-cemented joints.

K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:

1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
2. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water-hammer arresters.
11. Trap-seal primer valves.

B. Related Requirements:

1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Section 224713 "Drinking Fountains" for water filters for water coolers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze or Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Standard: ASSE 1012.
2. Operation: Continuous-pressure applications.
3. Size: NPS 1/2 (DN 15) or NPS 3/4 (DN 20).
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Chrome plated or Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
4. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved; steel with interior lining that complies with AWWA C550 or that is FDA approved; stainless steel for NPS 2-1/2 (DN 65) and larger.

5. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
6. Accessories:

    a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
4. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved; steel with interior lining that complies with AWWA C550 or that is FDA approved; stainless steel for NPS 2-1/2 (DN 65) and larger.
5. End Connections: Threaded for NPS 2 (DN 50) and smaller;
6. Accessories:

    a. ValvesNPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
    b. ValvesNPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Standard: ASSE 1003.
2. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
3. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
4. Valves for Booster Heater Water Supply: Include integral bypass.
5. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves:
1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 2 (DN 50) or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.

9. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:
1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig (860 kPa).
3. Type: Thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded union inlets and outlet.
6. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Tempered-Water Setting: 120 deg F (deg C).
8. Valve Finish: Chrome plated or Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:
1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig (860 kPa)minimum unless otherwise indicated.
3. Material: Bronze body with corrosion-resistant interior components.
4. Connections: Threaded union inlets and outlet.
5. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
6. Valve Finish: Chrome plated Polished, or chrome plated or Rough bronze.
7. Piping Finish: Chrome plated or Copper.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
    b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
    c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).

6. Drain: Factory-installed, hose-end drain valve.

2.9 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze or Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig (860 kPa).
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze or Chrome plated.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze or Rough bronze.
11. Operating Keys(s): One with each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig (860 kPa).
3. Operation: Loose key.
4. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
5. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
6. Outlet: Concealed.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze or Chrome plated.
9. Vacuum Breaker:

a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7 on outlet.

10. Operating Keys(s): One with each wall hydrant.

C. Moderate-Climate Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig (860 kPa).
3. Operation: Loose key.
4. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
5. Outlet:

a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7.

6. Box: Deep, flush mounted with cover.
7. Box and Cover Finish: Polished nickel bronze or Chrome plated.
8. Outlet:

a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7.

9. Nozzle and Wall-Plate Finish: Polished nickel or Rough bronze.
10. Operating Keys(s): One with each wall hydrant.

D. Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type A or Type B.
2. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
3. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
4. Pressure Rating: 125 psig (860 kPa).
5. Operation: Loose key or wheel handle.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.

3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
1. Standard: ASSE 1010 or PDI-WH 201.
2. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:
1. Standard: ASSE 1018.
2. Pressure Rating: 125 psig (860 kPa) minimum.
3. Body: Bronze.
4. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
5. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
6. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:
1. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 (DN 10) minimum, trap makeup connection.
2. Size: NPS 1-1/4 (DN 32) minimum.
3. Material: Chrome-plated, cast brass.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of each control valve water pressure-reducing valve solenoid valve and pump.

F. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.

G. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.

H. Install water-hammer arresters in water piping according to PDI-WH 201.

I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

J. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.fa

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.
2. Horizontally mounted, in-line, close-coupled centrifugal pumps.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

B. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Casing: Bronze, with threaded or companion-flange connections.
3. Impeller: Plastic.
4. Motor: Single speed, unless otherwise indicated.

2.2 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

B. Pump Construction:

1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
5. Bearings: Oil-lubricated; bronze-journal or ball type.
6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

C. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing. Variable speed acceptable.

D. Capacities and Characteristics:
1. Minimum Working Pressure: 175 psig.
2. Maximum Continuous Operating Temperature: 225 deg F.
3. Pump Control: Thermostat.
4. Electrical Characteristics:

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Operation of Pump: Varies based upon demand.
3. Transformer: Provide if required.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

C. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft horizontal.

D. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

E. Install thermostats in hot-water return piping.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
b. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties."
3. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

D. Connect thermostats to pumps that they control.

3.3 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

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

END OF SECTION 221123

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial, atmospheric, gas-fired, storage, domestic-water heaters.
2. Commercial, power-burner, gas-fired, storage, domestic-water heaters.
3. Commercial, grid-type, finned-tube, gas-fired, domestic-water heaters.
4. Residential, atmospheric, gas-fired, storage, domestic-water heaters.
5. Residential, power-vent, gas-fired, storage, domestic-water heaters.
6. Commercial, oil-fired, storage, domestic-water heaters.
7. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated.

B. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: One year(s).

b. Commercial, Finned-Tube, Gas-Fired, Domestic-Water Heaters:

1) Heat Exchanger: Three years.
2) Controls and Other Components: One year(s).
3) Separate Hot-Water Storage Tanks: Five years.

c. Residential, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: Two years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Atmospheric, Gas-Fired, Storage, Domestic-Water Heaters:
1. Standard: ANSI Z21.10.3/CSA 4.3.
2. Energy Star Certified
3. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) working-pressure rating.

a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 (DN 65) 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 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

4. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
e. Jacket: Steel with enameled finish.
f. Burner: For use with atmospheric, gas-fired, domestic-water heaters and natural-gas fuel.
g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
h. Temperature Control: Adjustable thermostat.
i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
j. 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.

5. Special Requirements: NSF 5 construction.
6. Draft Hood: Draft diverter, complying with ANSI Z21.12.

B. Commercial, Power-Burner, Gas-Fired, Storage, Domestic-Water Heaters:
1. Standard: ANSI Z21.10.3/CSA 4.3.
2. Energy Star Certified
3. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) working-pressure rating.

a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 (DN 65) 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 Annex barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

4. Factory-Installed Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
    d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
    e. Jacket: Steel with enameled finish.
    f. Burner: UL 795 for power-burner, gas-fired, domestic-water heaters and natural-gas fuel.
    g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
    h. Temperature Control: Adjustable thermostat.
    i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
    j. 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.

5. Special Requirements: NSF 5 construction.

2.2 COMMERCIAL, FINNED-TUBE, GAS-FIRED, DOMESTIC-WATER HEATERS

A. Commercial, Grid-Type, Finned-Tube, Gas-Fired, Domestic-Water Heaters:

1. Standard: ANSI Z21.13/CSA 4.9 for hot-water-supply boilers.
2. Energy Star Certified
3. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.
4. Boiler Construction: ASME code with 160-psig (1100-kPa) working-pressure rating for hot-water-boiler-type, domestic-water heater.

    a. Heat Exchanger: Horizontal, straight, finned-copper tubes with bronze headers.
    b. Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.

        1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
        2) NPS 2-1/2 (DN 65) 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.

5. Boiler Appurtenances:

    a. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire boiler except connections and controls.
    b. Jacket: Steel with enameled finish.
    c. Burner: For use with grid-type, finned-tube, gas-fired, domestic-water heaters and natural-gas fuel.

d. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, intermittent electronic-ignition system.
e. Temperature Control: Adjustable, storage-tank temperature-control fitting and flow switch, interlocked with circulator and burner.
f. Safety Control: Automatic, high-temperature-limit cutoff device or system.

6. Support: Steel base or skids.
7. Hot-Water Storage Tank: Connected with piping to circulating pump and domestic-water heater.

a. Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150-psig (1035-kPa) working-pressure rating.
b. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 (DN 65) 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.

c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

8. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rods: Factory installed, magnesium.
b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005, factory installed.
c. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
d. Jacket: Steel with enameled finish.
e. 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.

9. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.
10. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.
11. Mounting: Domestic-water heater, tank, and accessories factory mounted on skids.

B. Capacity and Characteristics:
1. Temperature Setting: 140 deg F (60 deg C).

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
2. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics:

    a. Working-Pressure Rating: 150 psig (1035 kPa).

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

H. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

J. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.

K. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base.

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Residential, Domestic-Water Heater Mounting: Install residential domestic-water heaters on water-heater stand on floor or domestic-water heater mounting bracket.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

D. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

E. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

F. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

H. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

I. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

K. Fill domestic-water heaters with water.

L. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION 223400

SECTION 224200 – PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Kitchen Aerators
2. Lavatory Aerators
3. Shower Heads
4. Water Closet Flush Valves

1.2 SUBMITTALS

A. Product Data: For each type of fixture product.

1. Include equipment, and supports and indicate materials and finishes, dimensions, and flow-control rates for each type of fixture indicated.
2. Water consumption data.

1.3 QUALITY ASSURANCE

A. Fixtures and trim where required to be accessible to disabled people, identified in this section as "for disabled," shall comply with requirements of the Americans with Disabilities Act (ADA) Regulations, as applicable to each type of fixture or its use.

1. Water closet models must be selected and installed so that flush controls will be on the fixture's open side.

1.4 GNERAL REQUIREMENTS

A. Basis-of-Design Product: These products are listed as examples that meet the performance specifications of the design. An alternate product that complies with all listed requirements for that fixture type shall be considered as comparable. It is the contractor's responsibility to ensure that the selected product – whether the example product or an alternate – is suitable for the existing conditions (finish, thread, dimensions, etc).

PART 2 - PRODUCTS

2.1 KITCHEN AERATOR **WF-1**

A. Performance Specification:

1. 1.5 GPM flow rate
2. Dual thread
3. Vandal resistant
4. Basis-of-Design Product: Neoperl Dual Thread Aerator 1.5 GPM

2.2 LAVATORY AERATOR **WF-2**

A. Performance Specification:

1. 1.0 GPM flow rate
2. Dual thread
3. Vandal resistant
4. Basis-of-Design Product: Neoperl Dual Thread Aerator 1.0 GPM

2.3 SHOWER HEAD **WF-3**

A. Performance Specification:

1. 1.5 GPM flow rate
2. Large diameter spray
3. Metal coupler
4. Basis-of-Design Product: Niagara Earth Handheld Showerhead 1.5 GPM

2.4 WATER CLOSET FLUSH VALVE **WF-4a**

A. Performance Specification:

1. 1.6 GPF Toilet flush valve
2. ADA-compliant
3. Basis-of-Design Product: Fluidmaster 400AH – Performax Fill Valve and Flapper 1.6 GPF

2.5 WATER CLOSET FLUSH VALVE **WF-4b**

A. Performance Specification:

1. 1.28 GPF Toilet flush valve

2. ADA-compliant

3. Basis-of-Design Product: Fluidmaster 400AH – Performax Fill Valve and Flapper 1.28 GPF

2.6 WATER CLOSET FLUSH VALVE **WF-4c**

A. Performance Specification:

1. 1.6 GPF Tankless toilet flush valve

2. ADA-compliant

3. Non-hold-open handle

4. Basis-of-Design Product: Sloan® Flush Valve Repair Master Kit For Royal And Regal Closet 1.6 GPF (Tankless)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine existing fixtures to ensure aerator finish matches existing, before plumbing fixture installation.

3.2 CONNECTIONS

A. Install new toilet shutoff valve where absent or damaged.

END OF SECTION 224200

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 1000 feet above sea level.

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

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Electrically commutated
4. Capacitor start, inductor run.
5. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Variable Speed Motors: Electronically commutated.

D. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

E. Motors 1/20 HP and Smaller: Shaded-pole type or electronically commutated.

F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel, Plastic or Stainless steel.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

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

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves and Galvanized-steel wall sleeves.
b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves and Galvanized-steel wall sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6 (DN 150) : Galvanized-steel-pipe sleeves.
b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.
6. Pitot-tube flowmeters.
7. Turbine flowmeters.
8. Venturi flowmeters.
9. Impeller-turbine, thermal-energy meters.

1.2 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

G. Window: Plain glass or plastic.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass or plastic.
7. Stem: Aluminum and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Plastic; 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass or plastic.
7. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.4 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch or 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass or plastic.
9. Ring: Metal.
10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Sealed type; plastic; 4-1/2-inch or 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass or plastic.
9. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled Sealed type; cast aluminum or drawn steel; 4-1/2-inch or 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass or plastic.
9. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled Sealed type; cast aluminum or drawn steel; 4-1/2-inch or 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass or plastic.
9. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.7 FLOWMETERS

A. Pitot-Tube Flowmeters:

1. Description: Flowmeter with sensor and indicator.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.

    a. Design: Differential-pressure-type measurement for water.
    b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
    c. Minimum Pressure Rating: 150 psig.
    d. Minimum Temperature Rating: 250 deg F.

4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
5. Integral Transformer: For low-voltage power connection.
6. Accuracy: Plus or minus 3 percent.
7. Display: Shows rate of flow, with register to indicate total volume in gallons.
8. Operating Instructions: Include complete instructions with each flowmeter.

B. Turbine Flowmeters:

1. Description: Flowmeter with sensor and indicator.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute.

    a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
    b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
    c. Minimum Pressure Rating: 150 psig.
    d. Minimum Temperature Rating: 180 deg F.

4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
5. Accuracy: Plus or minus 1-1/2 percent.
6. Display: Shows rate of flow, with register to indicate total volume in gallons.
7. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids (except steam).

K. Install valve and syphon fitting in piping for each pressure gage for steam.

L. Install flow indicators in piping systems in accessible positions for easy viewing.

M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

N. Install flowmeter elements in accessible positions in piping systems.

O. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

P. Install permanent indicators on walls or brackets in accessible and readable positions.

Q. Install connection fittings in accessible locations for attachment to portable indicators.

R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

S. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.

T. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

C. Thermometers at inlets and outlets of each chiller shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

E. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.

2. Industrial-style, liquid-in-glass type.

F. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

G. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

H. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

I. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C.

B. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

C. Scale Range for Chilled-Water Piping: 0 to 150 deg F.

D. Scale Range for Condenser-Water Piping: 0 to 100 deg F.

E. Scale Range for Condenser-Water Piping: 0 to 150 deg F.

F. Scale Range for Condenser-Water Piping: 0 to 250 deg F.

G. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.

H. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F.

I. Scale Range for Heating, Hot-Water Piping: 50 to 400 deg F.

J. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F.

K. Scale Range for Steam and Steam-Condensate Piping: 20 to 240 deg F.

L. Scale Range for Air Ducts: Minus 40 to plus 160 deg F.

M. Scale Range for Air Ducts: 0 to 100 deg F.

N. Scale Range for Air Ducts: 0 to 150 deg F.

O. Scale Range for Air Ducts: 20 to 240 deg F.

3.6 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi.

B. Scale Range for Chilled-Water Piping: 0 to 160 psi.

C. Scale Range for Chilled-Water Piping: 0 to 300 psi.

D. Scale Range for Condenser-Water Piping: 0 to 100 psi.

E. Scale Range for Condenser-Water Piping: 0 to 160 psi.

F. Scale Range for Condenser-Water Piping: 0 to 300 psi.

G. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

H. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi.

I. Scale Range for Heating, Hot-Water Piping: 0 to 300 psi.

J. Scale Range for Steam Piping: 0 to 100 psi.

K. Scale Range for Steam Piping: 0 to 160 psi.

L. Scale Range for Steam Piping: 0 to 200 psi.

END OF SECTION 230519

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B16.18 for solder-joint connections.
4. ASME B31.1 for power piping valves.
5. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. One-Piece Brass Ball Valves:
1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Forged brass.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. Two-Piece Brass Ball Valves with Full Port and Brass Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

C. Two-Piece Brass Ball Valves with Full Port and Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

D. Two-Piece Brass Ball Valves with Regular Port and Brass Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Regular.

E. Two-Piece Brass Ball Valves with Regular Port and Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Brass or bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Regular.

2.3 BRONZE BALL VALVES

A. One-Piece Bronze Ball Valves with Bronze Trim:
1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. One-Piece Bronze Ball Valves with Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig.
c. Body Design: One piece.
d. Body Material: Bronze.

e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Reduced.

C. Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

D. Two-Piece Bronze Ball Valves with Full Port and Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

E. Two-Piece Bronze Ball Valves with Regular Port and Bronze or Brass Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Regular.

F. Two-Piece Bronze Ball Valves with Regular Port and Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Regular.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3.3 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: One or Two piece, regular port, brass or bronze. Retain subparagraph below if solder-joint valve ends are permitted for this application.

1. Valves may be provided with solder-joint ends instead of threaded ends.

3.4 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: One or Two piece, regular port, brass or bronze. Retain subparagraph below if solder-joint valve ends are permitted for this application.

1. Valves may be provided with solder-joint ends instead of threaded ends.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: One or Two piece, regular port, brass or bronze. Retain subparagraph below if solder-joint valve ends are permitted for this application.

1. Valves may be provided with solder-joint ends instead of threaded ends.

3.6 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller: One or Two piece, regular port, brass or bronze. Retain subparagraph below if solder-joint valve ends are permitted for this application.

3.7 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe NPS 2 and Smaller: One or Two piece, regular port, brass or bronze. Retain subparagraph below if solder-joint valve ends are permitted for this application.

3.8 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: One or Two piece, regular port, brass or bronze. Retain subparagraph below if solder-joint valve ends are permitted for this application.

END OF SECTION 230523.12

SECTION 230523.13 - BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Iron, single-flange butterfly valves.
2. High-performance butterfly valves.
3. Chainwheels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B31.1 for power piping valves.
4. ASME B31.9 for building services piping valves.

C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.

F. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Stem: One- or two-piece stainless steel.
f. Disc: Aluminum bronze.

B. Iron, Single-Flange Butterfly Valves with Ductile-Iron Disc:
1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Stem: One- or two-piece stainless steel.
f. Disc: Nickel-plated or -coated ductile iron.

C. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:
1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Stem: One- or two-piece stainless steel.
f. Disc: Stainless steel.

2.3 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:
1. Description:

a. Standard: MSS SP-68.
b. CWP Rating: 285 psig at 100 deg F.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

B. Class 300, Single-Flange, High-Performance Butterfly Valves:
   1. Description:

      a. Standard: MSS SP-68.
      b. CWP Rating: 720 psig at 100 deg F.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      d. Body Material: Carbon steel, cast iron, or ductile iron.
      e. Seat: Reinforced PTFE or metal.
      f. Stem: Stainless steel; offset from seat plane.
      g. Disc: Carbon steel.
      h. Service: Bidirectional.

2.4 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

   1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
   2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

B.

END OF SECTION 230523.13

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze lift check valves.
2. Bronze swing check valves.
3. Iron swing check valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.1 for power piping valves.
6. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Description:

    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 200 psig.
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Description:

    a. Standard: MSS SP-80, Type 4.
    b. CWP Rating: 200 psig.
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: PTFE.

C. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Description:

    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 300 psig.
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: Bronze.

D. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
1. Description:

    a. Standard: MSS SP-80, Type 4.
    b. CWP Rating: 300 psig.
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: PTFE.

2.3 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Description:

    a. Standard: MSS SP-71, Type I.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
    c. NPS 14 to NPS 24, CWP Rating: 150 psig.
    d. Body Design: Clear or full waterway.
    e. Body Material: ASTM A 126, gray iron with bolted bonnet.
    f. Ends: Flanged.

g. Trim: Bronze.
h. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Composition.
h. Seat Ring: Bronze.
i. Disc Holder: Bronze.
j. Disc: PTFE.
k. Gasket: Asbestos free.

C. Class 250, Iron Swing Check Valves with Metal Seats:
1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.4 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:
1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and weight.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring; metal or resilient-seat check valves.

B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.

3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
3. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

3.5 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
3. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.

3. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

3.7 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
3. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

3.8 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe NPS 2 and Smaller:

1. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.

B. Pipe Sizes NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
3. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.

3.9 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.

END OF SECTION 230523.14

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.5 EQUIPMENT SUPPORTS

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

2.6 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.

7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch stainless steel, 0.025-inch, aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch or 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch or 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover 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; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch or 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.
b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.
b. Variable-flow hydronic systems.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 ACTION SUBMITTALS

1.4 INFORMATIONAL SUBMITTALS

A. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

B. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC, NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures for balancing the systems.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

    a. Duct systems are complete with terminals installed.
    b. Volume, smoke, and fire dampers are open and functional.
    c. Clean filters are installed.
    d. Fans are operating, free of vibration, and rotating in correct direction.
    e. Variable-frequency controllers' startup is complete and safeties are verified.
    f. Automatic temperature-control systems are operational.
    g. Ceilings are installed.
    h. Windows and doors are installed.
    i. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

    a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.

b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance"; ASHRAE 111; NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"; SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from Architect Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor

amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
    g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
    b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
    b. Re-measure and confirm that total airflow is within design.
    c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
    d. Mark final settings.
    e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
    f. Verify tracking between supply and return fans.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gage heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.

4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.

3) Convert pressure to head and correct for differences in gage heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

a. Measure differential pressure and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

a. Measure differential pressure, and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
c. Mark final settings.

13. Verify that memory stops have been set.

3.10 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.11 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

6. Balancing stations.
7. Position of balancing devices.

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

1. Unit Data:

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

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Preheat-coil static-pressure differential in inches wg.
    g. Cooling-coil static-pressure differential in inches wg.
    h. Heating-coil static-pressure differential in inches wg.
    i. Outdoor airflow in cfm.
    j. Return airflow in cfm.
    k. Outdoor-air damper position.
    l. Return-air damper position.
    m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

    a. System identification.
    b. Location.
    c. Coil type.

d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.

d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft..
    g. Indicated airflow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual airflow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Apparatus used for test.
    d. Area served.
    e. Make.
    f. Number from system diagram.
    g. Type and model number.
    h. Size.
    i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.12 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.

B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Chilled-water and brine piping, indoors and outdoors.
2. Heating hot-water piping, indoors and outdoors.
3. Refrigerant suction and hot-gas piping, indoors and outdoors.
4. Dual-service heating and cooling piping, indoors and outdoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Block Insulation: ASTM C 552, Type I.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Board Insulation: ASTM C 552, Type IV.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
2. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of

insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

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

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

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

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White unless otherwise specified by owner.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
1. Sheet and roll stock ready for shop or field sizing.
2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
5. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Tee covers.
    d. Flange and union covers.
    e. End caps.
    f. Beveled collars.
    g. Valve covers.
    h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

F. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

G. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.9 TAPES

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

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

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches.
   2. Thickness: 3.7 mils.
   3. Adhesion: 100 ounces force/inch in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   1. Width: 3 inches.
   2. Film Thickness: 4 mils.
   3. Adhesive Thickness: 1.5 mils.
   4. Elongation at Break: 145 percent.
   5. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   1. Width: 3 inches.
   2. Film Thickness: 6 mils.
   3. Adhesive Thickness: 1.5 mils.
   4. Elongation at Break: 145 percent.

5. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

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

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

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

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

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer

to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.

4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

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

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

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Chilled Water and Brine, above 40 Deg F: Insulation shall be[**one of**] the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 2 inches thick.
4. Polyolefin: 1 inch thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below: Insulation shall be[**one of**] the following:

1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric, 1 inch thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric, 1 inch thick.

E. Dual-Service Heating and Cooling, 40 to 200 Deg F: Insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine: Insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Flexible Elastomeric: 3 inches thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.
4. Polyolefin: 3 inches thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below: Insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.

2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Piping: Insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 2 inches thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
4. Polyolefin: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be one of the following:

1. Flexible Elastomeric: 2 inches thick.
2. Polyolefin: 2 inches thick.

E. Dual-Service Heating and Cooling: Insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.15 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Section 232113.13 "Underground Hydronic Piping" and Section 336313 "Underground Steam and Condensate Distribution Piping."

B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.

C. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F and Below: Cellular glass, 3 inches thick.

D. Dual-Service Heating and Cooling, All Sizes, 40 to 200 Deg F: Cellular glass, 3 inches thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. PVC: At least 20 mils thick.
3. Aluminum, Smooth or corrugated: 0.020 inch thick.

D. Piping, Exposed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, Smooth or corrugated: 0.020 inch thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. Aluminum, Smooth or corrugated: 0.032 inch thick.
3.

D. Piping, Exposed:

1. PVC: 30 mils thick.

3.18 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

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

END OF SECTION 230719

SECTION 230923.11 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control valves and actuators for DDC systems.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.
2. Include diagrams for pneumatic signal and main air tubing.

C. Delegated-Design Submittal:

1. Schedule and design calculations for control valves and actuators, including the following:

a. Flow at project design and minimum flow conditions.
b. Pressure differential drop across valve at project design flow condition.
c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
d. Design and minimum control valve coefficient with corresponding valve position.
e. Maximum close-off pressure.
f. Leakage flow at maximum system pressure differential.
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Delegated Design: Engage a qualified professional, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

E. Determine control valve sizes and flow coefficients by ISA 75.01.01.

F. Control valve characteristics and rangeability shall comply with ISA 75.11.01.

G. Selection Criteria:

1. Fail positions unless otherwise indicated:
   a. Heating Hot Water: Open.
   b. Steam: Open..

2. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
3. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig ((34 kPa)) at design flow unless otherwise indicated.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Single Port and Characterized Disk:

1. Pressure Rating for NPS 1 ((DN 25)) and Smaller: Nominal 600 WOG.
2. Pressure Rating for NPS 1-1/2 (DN 38) through NPS 2 (DN 50): Nominal 400 WOG.
3. Close-off Pressure: 200 psig (1379 kPa).
4. Process Temperature Range: Zero to 212 deg F (Minus 18 to plus 100 deg C).
5. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
6. End Connections: Threaded (NPT) ends.
7. Ball: Chrome-plated brass or bronze or 300 series stainless steel.
8. Stem and Stem Extension:

   a. Material to match ball.
   b. Blowout-proof design.
   c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.

9. Ball Seats: Reinforced PTFE.

10. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
11. Flow Characteristic: Equal percentage.

B. Ball Valves with Two Ports and Characterized Disk:

1. Pressure Rating for NPS 1 (DN 25) and Smaller: Nominal 600 WOG.
2. Pressure Rating for NPS 1-1/2 (DN 38) through NPS 2 (DN 50): Nominal 400 WOG.
3. Close-off Pressure: 200 psig (1379 kPa).
4. Process Temperature Range: Zero to 212 deg F (Minus 18 to plus 100 deg C).
5. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
6. End Connections: Threaded (NPT) ends.
7. Ball: Chrome-plated brass or bronze or 300 series stainless steel.
8. Stem and Stem Extension:

    a. Material to match ball.
    b. Blowout-proof design.
    c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.

9. Ball Seats: Reinforced PTFE.
10. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
11. Flow Characteristics for A-Port: Equal percentage.
12. Flow Characteristics for B-Port: Modified for constant common port flow.

C. Pressure-Independent Ball Valves NPS 2 (DN 50) and Smaller:

1. Performance:

    a. Pressure Rating: 600 psig (4137 kPa) for NPS 1 (DN 25) and 400 psig (2528 kPa) for NPS 1-1/2 and NPS 2 (DN 38 and DN 50).
    b. Close-off pressure of 200 psig (1379 kPa).
    c. Process Temperature Range: Between zero to 212 deg F (minus 18 to plus 100 deg C).
    d. Rangeability: 100 to 1.

2. Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of 5 to 50 psig ((34 to 345 kPa)).
3. Body: Forged brass, nickel plated, and with threaded ends.
4. Ball: Chrome-plated brass.
5. Stem and Stem Extension: Chrome-plated brass, blowout-proof design.
6. Stem sleeve or other approved means to allow valve to be opened and closed without damaging field-applied insulation and insulation vapor barrier seal.
7. Ball Seats: Reinforced PTFE.

8. Stem Seal: Reinforced PTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.
9. Flow Characteristic: Equal percentage.

2.3 BUTTERFLY-STYLE CONTROL VALVES

A. Commercial-Grade, Two-Way Butterfly Valves:

1. Performance:

    a. Bi-directional bubble tight shutoff at 250 psig (1724 kPa).
    b. Comply with MSS SP-67 or MSS SP-68.
    c. Rotation: Zero to 90 degrees.
    d. Linear or modified equal percentage flow characteristic.

2. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
3. Disc: 316 stainless steel.
4. Shaft: 316 or 17-4 PH stainless steel.
5. Seat: Reinforced EPDM or reinforced PTFE with retaining ring.
6. Shaft Bushings: Reinforced PTFE or stainless steel.
7. Replaceable seat, disc, and shaft bushings.
8. Corrosion-resistant nameplate indicating:

    a. Manufacturer's name, model number, and serial number.
    b. Body size.
    c. Body and trim materials.
    d. Flow arrow.

B. Commercial-Grade, Three-Way Butterfly Valves:

1. Arrangement: Two valves mated to a fabricated tee with interconnecting mechanical linkage.
2. Performance:

    a. Bi-directional bubble tight shutoff at 250 psig (1724 kPa).
    b. Comply with MSS SP-67 or MSS SP-68.
    c. Rotation: Zero to 90 degrees.
    d. Linear or modified equal percentage flow characteristic.

3. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
4. Disc: 316 stainless steel.
5. Shaft: 316 or 17-4 PH stainless steel.
6. Seat: Reinforced EPDM or reinforced PTFE seat with retaining ring.
7. Shaft Bushings: Reinforced PTFE or stainless steel.
8. Replaceable seat, disc, and shaft bushings.
9. Corrosion-resistant nameplate indicating:

a. Manufacturer's name, model number, and serial number.
b. Body size.
c. Body and trim materials.
d. Flow arrow.

2.4 GLOBE-STYLE CONTROL VALVES

A. General Globe-Style Valve Requirements:

1. Globe-style control valve body dimensions shall comply with ISA 75.08.01.
2. Construct the valves to be serviceable from the top.
3. For cage guided valves, trim shall be field interchangeable for different valve flow characteristics, such as equal percentage, linear, and quick opening.
4. Reduced trim for one nominal size smaller shall be available for industrial valves NPS 1 (DN 25) and larger.
5. Replaceable seats and plugs.
6. Furnish each control valve with a corrosion-resistant nameplate indicating the following:

a. Manufacturer's name, model number, and serial number.
b. Body and trim size.
c. Arrow indicating direction of flow.

B. Two-Way Globe Valves NPS 2 (DN 50) and Smaller:

1. Globe Style: Single port.
2. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
3. End Connections: Threaded.
4. Bonnet: Screwed.
5. Packing: PTFE V-ring.
6. Plug: Top guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Range: 35 to 248 deg F (2 to 120 deg C).
9. Ambient Operating Temperature: 35 to 150 deg F (2 to 65 deg C).
10. Leakage: FCI 70-2, Class IV.
11. Rangeability: 25 to 1.
12. Equal percentage flow characteristic.

C. Three-Way Globe Valves NPS 2 (DN 50) and Smaller:

1. Globe Style: Mix flow pattern.
2. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
3. End Connections: Threaded.
4. Bonnet: Screwed.
5. Packing: PTFE V-ring.
6. Plug: Top guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Range: 35 to 248 deg F (2 to 120 deg C).
9. Ambient Operating Temperature: 35 to 150 deg F (2 to 65 deg C).
10. Leakage: FCI 70-2, Class IV.
11. Rangeability: 25 to 1.

12. Linear flow characteristic.

D. Two-Way Globe Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150):

1. Globe Style: Single port.
2. Body: Cast iron complying with ASME B61.1, Class 125.
3. End Connections: Flanged, suitable for mating to ASME B16.5, Class 150 flanges.
4. Bonnet: Bolted.
5. Packing: PTFE cone-ring.
6. Plug: Top or bottom guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Rating: 35 to 281 deg F (2 to 138 deg C).
9. Leakage: 0.1 percent of maximum flow.
10. Rangeability: Varies with valve size between 6 and 10 to 1.
11. Modified linear flow characteristic.

E. Industrial-Grade Straight-Through Globe Valves NPS 1 (DN 25) and Larger:

1. Globe Style: Single port.
2. Body: Cast iron or cast steel.
3. End Connections for NPS 2 (DN 50): Threaded.
4. End Connections for NPS 2-1/2 (DN 65) and Larger: Raised face flanged.
5. Bonnet: Bolted.
6. Packing: PTFE V-ring.
7. Plug: Cage guided and unbalanced.
8. Plug, Seat, and Stem: 416 stainless-steel plug and seat, 17-4 PH stainless-steel cage and 316 stainless-steel stem.
9. Valve Stem: Thread and pin stem to plug.
10. Valve Stem Finish: Polished to 5 microinches rms or less.
11. Plug and Seat Surfaces: Hardened facing.
12. Process Temperature Range: Zero to 450 deg F ((Minus 18 to plus 232 deg C)).
13. Ambient Operating Temperature: Minus 20 to plus 150 deg F (Minus 29 to plus 71 deg C).

2.5 SOLENOID VALVES

A. Description:

1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application.
2. Size to close against the system pressure.
3. Manual override capable.
4. Heavy-duty assembly.
5. Body: Brass or stainless steel.
6. Seats and Discs: NBR or PTFE.
7. Solenoid Enclosure: NEMA 250, Type 4.

2.6 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.

B. Actuators for Steam Control Valves: Shutoff against 1.2 times steam design pressure.

C. Position indicator and graduated scale on each actuator.

D. Type: Motor operated, with or without gears, electric and electronic.

E. Voltage: Voltage selection delegated to professional designing control system.

F. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

G. Function properly within a range of 85 to 120 percent of nameplate voltage.

H. Construction:

1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

I. Field Adjustment:

1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

J. Two-Position Actuators: Single direction, spring return or reversing type.

K. Modulating Actuators:

1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:

a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.

c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
d. Programmable Multi-Function:

1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

L. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

M. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

N. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

O. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F ((minus 29 to plus 49 deg C)).

P. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

PART 3 - EXECUTION

3.1 CONTROL VALVE APPLICATIONS

A. Control Valves:

1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.

E. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

G. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including. but not limited to, the following:

    a. Laboratory exhaust airstreams.
    b. Process exhaust airstreams.

3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

5. Where control devices are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 CONTROL VALVES

A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.

D. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than NPS 2 ((DN 50)).

E. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 1 (DN 25).

F. Valve Orientation:

1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
2. Install valves in a position to allow full stem movement.
3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

G. Clearance:

1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
2. Install valves with at least 12 inches (300 mm) of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
2. Align threads at point of assembly.
3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

J. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

K. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

L. Install engraved phenolic nameplate with valve identification on valve.

3.5 CHECKOUT PROCEDURES

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. For pneumatic products, verify air supply for each product is properly installed.
5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
6. Verify that control valves are installed correctly for flow direction.
7. Verify that valve body attachment is properly secured and sealed.
8. Verify that valve actuator and linkage attachment are secure.
9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
10. Verify that valve ball, disc, and plug travel are unobstructed.
11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.6 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.11

SECTION 230923.27 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air temperature sensors.
2. Air temperature switches.
3. Air temperature RTD transmitters.
4. Liquid and steam temperature sensors.
5. High-end, commercial-grade, liquid and steam temperature sensors.
6. Liquid temperature switches.
7. High-end, commercial-grade, liquid and steam temperature transmitters.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

    a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, filtered, and ventilated as required by instrument and application.

2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:

    a. Outdoors, Protected: Type 3.
    b. Outdoors, Unprotected: Type 4.
    c. Indoors, Heated with Filtered Ventilation: Type 1.
    d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
    e. Indoors, Heated and Air Conditioned: Type 1.
    f. Mechanical Equipment Rooms:

        1) Chiller and Boiler Rooms: Type 12.
        2) Air-Moving Equipment Rooms: Type 1.

    g. Localized Areas Exposed to Washdown: Type 4.
    h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
    i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
    j. Hazardous Locations: Explosion-proof rating for condition.

2.2 AIR TEMPERATURE SENSORS

A. Platinum RTDs: Common Requirements:

1. 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:

    a. Range: Minus 50 to 275 deg F (Minus 46 to 135 deg C).
    b. Interchangeable Accuracy: At 32 deg F (zero deg C) within 0.5 deg F (0.3 deg C).
    c. Repeatability: Within 0.5 deg F (0.3 deg C).
    d. Self-Heating: Negligible.

4. Transmitter Requirements:

    a. Transmitter required for each 100-ohm RTD.

b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.

B. Platinum RTD, Single-Point Air Temperature Duct Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
3. Probe: Single-point sensor with a stainless-steel sheath.
4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches ((450 mm) long).
5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
6. Gasket for attachment to duct or equipment to seal penetration airtight.
7. Conduit Connection: 1/2-inch ((16-mm) trade size.)

C. Platinum RTD, Air Temperature Averaging Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
3. Multiple sensors to provide average temperature across entire length of sensor.
4. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
5. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch (100-mm) radius.
6. Length: As required by application to cover entire cross section of air tunnel.
7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
8. Gasket for attachment to duct or equipment to seal penetration airtight.
9. Conduit Connection: 1/2-inch ((16-mm) trade size.)

D. Platinum RTD Outdoor Air Temperature Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
3. Probe: Single-point sensor with a stainless-steel sheath.
4. Solar Shield: Stainless steel.
5. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
6. Conduit Connection: 1/2-inch (16-mm) trade size.

E. Platinum RTD Space Air Temperature Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 212 deg F ((Minus 45 to 100 deg C).)
3. Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic or flush, brushed aluminum cover.
4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
5. Concealed wiring connection.

F. Thermal Resistors (Thermistors): Common Requirements:

1. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:

    a. Range: Minus 50 to 275 deg F (Minus 46 to 135 deg C).
    b. Interchangeable Accuracy: At 77 deg F (25 deg C) within 0.5 deg F (0.3 deg C).
    c. Repeatability: Within 0.5 deg F (0.3 deg C).
    d. Drift: Within 0.5 deg F (0.3 deg C) over 10 years.
    e. Self-Heating: Negligible.

4. Transmitter optional, contingent on compliance with end-to-end control accuracy.

G. Thermistor, Single-Point Duct Air Temperature Sensors:

1. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
2. Probe: Single-point sensor with a stainless-steel sheath.
3. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches ((450 mm) long).
4. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
5. Gasket for attachment to duct or equipment to seal penetration airtight.
6. Conduit Connection: 1/2- inch (16-mm) trade size.

H. Thermistor Averaging Air Temperature Sensors:

1. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
2. Multiple sensors to provide average temperature across entire length of sensor.
3. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
4. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch (100-mm) radius.
5. Length: As required by application to cover entire cross section of air tunnel.
6. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
7. Gasket for attachment to duct or equipment to seal penetration airtight.
8. Conduit Connection: 1/2-inch (16-mm) trade size.

I. Thermistor Outdoor Air Temperature Sensors:

1. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
2. Probe: Single-point sensor with a stainless-steel sheath.
3. Solar Shield: Stainless steel.
4. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
5. Conduit Connection: 1/2-inch (16-mm) trade size.

J. Thermistor Space Air Temperature Sensors:

1. Temperature Range: Minus 50 to 212 deg F ((Minus 45 to 100 deg C).)
2. Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic or flush, brushed aluminum cover.

3. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
4. Concealed wiring connection.

K. Space Air Temperature Sensors for Use with DDC Controllers Controlling Terminal Units:

1. 100- or 1000-ohm platinum RTD or thermistor.
2. Thermistor:

   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.
   b. Thermistor drift shall be less than plus or minus 0.5 deg F (0.3 deg C) over 10 years.

3. Temperature Transmitter Requirements:

   a. Mating transmitter required with each 100-ohm RTD.
   b. Mating transmitters optional for 1000-ohm RTD and thermistor, contingent on compliance with end-to-end control accuracy.

4. Provide digital display of sensed temperature.
5. Provide sensor with local control.

   a. Local override to turn HVAC on.
   b. Local adjustment of temperature set point.
   c. Both features shall be capable of manual override through control system operator.

2.3 AIR TEMPERATURE SWITCHES

A. Thermostat and Switch for Low Temperature Control in Duct Applications:

1. Description:

   a. Two-position control.
   b. Field-adjustable set point.
   c. Manual reset.
   d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Performance:

   a. Operating Temperature Range: 15 to 55 deg F (Minus 9 to 13 deg C).
   b. Temperature Differential: 5 deg F (2.8 deg C), non-adjustable and additive.
   c. Enclosure Ambient Temperature: Minus 20 to 140 deg F (Minus 11 to 60 deg C).
   d. Sensing Element Maximum Temperature: 250 deg F (121 deg C).
   e. Voltage: 120-V ac.
   f. Current: 16 FLA.
   g. Switch Type: Two SPDT snap switches operate on coldest 12-inch (300-mm)section along element length.

3. Construction:

    a. Vapor-Filled Sensing Element: Nominal 20 feet (6 m) long.
    b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.
    c. Set-Point Adjustment: Screw.
    d. Enclosure: Painted metal, NEMA 250, Type 1.
    e. Electrical Connections: Screw terminals.
    f. Conduit Connection: 1/2-inch (16-mm) trade size.

B. Thermostat and Switch for High Temperature Control in Duct Applications:
1. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
2. Description:

    a. Two-position control.
    b. Field-adjustable set point.
    c. Manual reset.
    d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Performance:

    a. Temperature Range: 100 to 160 deg F (38 to 71 deg C).
    b. Temperature Differential: 5 deg F (2.8 deg C).
    c. Ambient Temperature: Zero to 260 deg F (Minus 18 to 127 deg C).
    d. Voltage: 120-V ac.
    e. Current: 16 FLA.
    f. Switch Type: SPDT snap switch.

4. Construction:

    a. Sensing Element: Helical bimetal.
    b. Enclosure: Metal, NEMA 250, Type 1.
    c. Electrical Connections: Screw terminals.
    d. Conduit Connection: 1/2-inch (16-mm) trade size.

2.4 AIR TEMPERATURE RTD TRANSMITTERS

A. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.

B. House electronics in NEMA 250 enclosure.

1. Duct: Type 1.
2. Outdoor: Type 4.
3. Space: Type 1.

C. Conduit Connection: 1/2-inch ((16-mm) trade size.)

D. Functional Characteristics:

1. Input:

    a. 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
    b. 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.

2. Span (Adjustable):

    a. Space: 40 to 90 deg F (4 to 32 deg C).
    b. Supply Air Cooling and Heating: 40 to 120 deg F (4 to 49 deg C).
    c. Supply Air Cooling Only: 40 to 90 deg F (4 to 32 deg C).
    d. Supply Air Heating Only: 40 to 120 deg F (4 to 49 deg C).
    e. Exhaust Air: 50 to 100 deg F (10 to 38 deg C).
    f. Return Air: 50 to 100 deg F (10 to 38 deg C).
    g. Mixed Air: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
    h. Outdoor: Minus 40 to 140 deg F (Minus 40 to 60 deg C).

3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc .
4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F (28 deg C).
5. Match sensor with temperature transmitter and factory calibrate together.

E. Performance Characteristics:

1. Calibration Accuracy: Within 0.1 percent of the span.
2. Stability: Within 0.2 percent of the span for at least 6 months.
3. Combined Accuracy: Within 0.5 percent.

2.5 LIQUID AND STEAM TEMPERATURE SENSORS, COMMERCIAL GRADE

A. RTD:

1. Description:

    a. Platinum with a value of 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
    b. Encase RTD in a stainless-steel sheath with a 0.25-inch (6-mm) OD.
    c. Sensor Length: 4, 6, or 8 inches ((100, 150, or 200 mm))as required by application.
    d. Process Connection: Threaded, NPS 1/2 ((DN 15).)
    e. Two-stranded copper lead wires.
    f. Powder-coated steel enclosure, NEMA 250, Type 4.
    g. Conduit Connection: 1/2-inch ((16-mm) trade size.)
    h. Performance Characteristics:

        1) Range: Minus 40 to 210 deg F (Minus 40 to 99 deg C).
        2) Interchangeable Accuracy: Within 0.54 deg F (0.3 deg C) at 32 deg F (zero deg C).

B. Thermowells:

1. Stem: Straight or stepped shank formed from solid bar stock.
2. Material: Brass or stainless steel.
3. Process Connection: Threaded, NPS 3/4 (DN 20).
4. Sensor Connection: Threaded, NPS 1/2 (DN 15).
5. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
6. Furnish thermowells installed in insulated pipes and equipment with an extended neck.
7. Length: 4, 6, or 8 inches ((100, 150, or 200 mm))as required by application.
8. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

2.6 LIQUID AND STEAM TEMPERATURE SENSORS, HIGH-END COMMERCIAL GRADE

A. RTD:

1. Resistance temperature sensors shall comply with IEC 60751, Class B requirements.
2. Platinum with a value of 100 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
3. Encase RTD in a Type 316 stainless-steel sheath with a 0.25-inch (8-mm) OD.
4. Provide spring-loaded RTDs for thermowell installations.
5. Performance Characteristics:

    a. Range: Minus 328 to 932 deg F (Minus 200 to 500 deg C).
    b. Interchangeable Accuracy: Within 0.54 deg F (0.3 deg C) at 32 deg F (zero deg C).
    c. Stability: Within 0.05 percent maximum ice-point resistance shift after 1000 hours at 752 deg F (400 deg C).
    d. Hysteresis: Within 0.04 percent of range.
    e. Response Time: 62.8 percent of change in 4 seconds with water flowing across sensor at 3 fps (0.9 m/s).

B. Thermowells:

1. Stem: Straight or stepped or tapered shank formed from solid bar stock.
2. Material: Type 304 or Type 316 stainless steel.
3. Process Connection: Threaded, NPS 3/4 ((DN 20).)
4. Sensor Connection: Threaded, NPS 1/2 ((DN 15).)
5. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
6. Furnish thermowells installed in insulated pipes and equipment with an extended neck that extends beyond the face of the insulation covering.
7. Length: As required by application and pipe size.
8. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

C. Connection Heads:

1. Housing: Low-copper cast-aluminum alloy, complying with NEMA 250, Type 4.
2. Terminals: Six or eight as required by sensor.
3. Conduit Connection: 1/2-inch (16-mm) trade size.
4. Sensor Connection: NPS 1/2 (DN 15).

D. Assembly: Sensor manufacturer shall furnish sensor, thermowell, and sensor connection head to provide a matched assembly.

2.7 LIQUID TEMPERATURE SWITCHES

A. Thermostat and Switch for Temperature Control in Pipe Applications:

1. Description:

a. Two-position control.
b. Field-adjustable set point.
c. Manual reset.
d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Performance:

a. Operating Temperature Range: 65 to 200 deg F (18 to 3 deg C).
b. Temperature Differential Deadband: 5 to 30 deg F (3 to 17 deg C), adjustable.
c. Enclosure Ambient Temperature: 150 deg F (66 deg C).
d. Sensing Element Pressure Rating: 200 psig (1379 kPa).
e. Voltage: 120-V ac.
f. Current: 8 FLA.
g. Switch Type: SPDT snap switch.

3. Construction:

a. Vapor-Filled Immersion Element: Copper, nominal 3 inches (75 mm)long.
b. Temperature Scale: Fahrenheit, visible on face.
c. Set-Point Adjustment: Screw.
d. Enclosure: Painted metal, NEMA 250, Type 1.
e. Electrical Connections: Screw terminals.
f. Conduit Connection: 3/4-inch ((21-mm) trade size).

2.8 LIQUID AND STEAM TEMPERATURE TRANSMITTERS, COMMERCIAL GRADE

A. House electronics in NEMA 250, Type 4 enclosure.

B. Enclosure Connection: 1/2-inch (16-mm) trade size.

C. Functional Characteristics:

1. Input: 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two- or three-wire sensors.
2. Default Span (Adjustable):

a. Chilled Water: Zero to 100 deg F (Minus 18 to 38 deg C).
b. Condenser Water: Zero to 120 deg F (Minus 18 to 49 deg C).
c. Heating Hot Water: 32 to 212 deg F (Zero to 100 deg C).
d. Heat Recovery: Zero to 120 deg F (Minus 18 to 49 deg C).

3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F (28 deg C).
5. Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.

D. Performance Characteristics:

1. Calibration Accuracy: Within 0.1 percent of the span.
2. Stability: Within 0.2 percent of the span for at least 6 months.
3. Combined Accuracy: Within 0.5 percent.

PART 3 - EXECUTION

3.1 TEMPERATURE INSTRUMENT APPLICATIONS

A. Air Temperature Sensors:

1. Duct: Thermistor 100-ohm platinum RTD.
2. Outdoor: Thermistor 100-ohm platinum RTD.
3. Space: Thermistor 100-ohm platinum RTD.

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

C. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 TEMPERATURE INSTRUMENT INSTALLATIONS

A. Mounting Location:

1. Roughing In:

   a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
   b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.

      1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
      2) Do not begin installation without submittal approval of mounting location.

   c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to

accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches (1.1 to 1.6 m) above the adjacent floor, grade, or service catwalk or platform.

    a. Make every effort to mount at 60 inches (1500 mm).

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Space Temperature Sensor Installation:

1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
3. In finished areas, recess electrical box within wall.
4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Outdoor Air Temperature Sensor Installation:

1. Mount sensor in a discrete location facing north.
2. Protect installed sensor from solar radiation and other influences that could impact performance.
3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Single-Point Duct Temperature Sensor Installation:

1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches (610 mm) in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.

H. Averaging Duct Temperature Sensor Installation:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. (1.86 sq. m) and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Low-Limit Air Temperature Switch Installation:

1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

J. Liquid Temperature Sensor Installation:

1. Assembly shall include sensor, thermowell.
2. For pipe NPS 4 (DN 100) and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4 (DN 100):

    a. Install reducers to increase pipe size to NPS 4 ((DN 100))at point of thermowell installation.
    b. For pipe sizes NPS 2-1/2 and NPS 3 (DN 65 and DN 80), thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
    c. Minimum insertion depth shall be 2-1/2 inches (65 mm).

4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.

8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

3.6 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.7 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.

D. Verify location and length.

E. Verify that wiring is correct and secure.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform according to manufacturer's written instruction.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

END OF SECTION 230923.27

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

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.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
1. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
2. Coating: PE with flame retardant.

    a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.

3. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
4. Striker Plates: Steel, designed to protect tubing from penetrations.
5. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
6. Operating-Pressure Rating: 5 psig.

C. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded or suitable for welded connection.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Outlet shall be threaded or suitable for welded connection.
    c. Bridging sleeve over mechanical coupling.
    d. Factory-connected anode.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.

7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated brass.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Separate packnut with adjustable-stem packing threaded ends.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
2. Plug: Bronze.
3. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. PE Ball Valves: Comply with ASME B16.40.
1. Body: PE.
2. Ball: PE.
3. Stem: Acetal.
4. Seats and Seals: Nitrile.
5. Ends: Plain or fusible to match piping.
6. CWP Rating: 80 psig.
7. Operating Temperature: Minus 20 to plus 140 deg F.
8. Operator: Nut or flat head for key operation.
9. Include plastic valve extension.
10. Include tamperproof locking feature for valves where indicated on Drawings.

H. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.
1. Pilot operated.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
6. NEMA ICS 6, Type 4, coil enclosure.
7. Normally closed.
8. Visual position indicator.

2.6 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.
1. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
2. Maximum Operating Pressure: 5 psig.
3. Cast-aluminum body with nickel-plated chrome steel internal parts.
4. Nitrile-rubber valve washer.
5. Sight windows for visual indication of valve position.
6. Threaded end connections complying with ASME B1.20.1.
7. Wall mounting bracket with bubble level indicator.

2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.8 DIELECTRIC UNIONS

A. Dielectric Unions:
1. Description:

a. Standard: ASSE 1079.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

2.9 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective

jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

F. Install fittings for changes in direction and branch connections.

3.2 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

S. Do not use natural-gas piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be one of the following:

1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
2. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.

C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.10 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
3. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.11 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground: PE or Bronze plug valves.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

C. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 231123

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condenser-water piping.
4. Makeup-water piping.
5. Condensate-drain piping.
6. Blowdown-drain piping.
7. Air-vent piping.
8. Safety-valve-inlet and -outlet piping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.
2. RTRP and RTRF with adhesive.
3. Pressure-seal fittings.
4. Chemical treatment.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Condensate-Drain Piping: 150 deg F.
   2. Blowdown-Drain Piping: 200 deg F.
   3. Air-Vent Piping: 200 deg F.
   4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type M.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.
   1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
   2. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

E. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

   1. Material Group: 1.1.

2. End Connections: Butt welding.
3. Facings: Raised face.

G. Grooved Mechanical-Joint Fittings and Couplings:
1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
2. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.4 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.

1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.

1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
b. Adhesive primer shall have a VOC content of 550 g/L or less.
c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

a. PVC solvent cement shall have a VOC content of 510 g/L or less.
b. Adhesive primer shall have a VOC content of 550 g/L or less.
c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:
1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.8 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

C. Hot-Water Heating Piping Installed Belowground and within Slabs:Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

D. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

E. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

F. Chilled-Water Piping Installed Belowground and within Slabs:Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

G. Condenser-water piping, aboveground, NPS 2 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

H. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

I. Condenser-Water Piping Installed Belowground and within Slabs:Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

J. Makeup-water piping installed aboveground shall be either of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 CPVC plastic pipe and fittings, and solvent-welded joints.

K. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

L. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

M. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

N. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

O. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

P. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains usingtee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

A. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

B. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condenser-water piping.
4. Makeup-water piping.
5. Condensate-drain piping.
6. Blowdown-drain piping.
7. Air-vent piping.
8. Safety-valve-inlet and -outlet piping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230923.11 "Control Valves"Section 15901 "Control Valves."

C. Plastic Ball Valves:
1. Body: One-, two-, or three-piece CPVC or PVC to match piping.
2. Ball: Full-port CPVC or PVC to match piping.
3. Seats: PTFE.
4. Seals: EPDM.
5. End Connections: Socket, union, or flanged.
6. Handle Style: Tee shape.
7. CWP Rating: Equal to piping service.
8. Maximum Operating Temperature: Equal to piping service.
9. Comply with MSS SP-122.

D. Plastic Butterfly Valves:
1. Body: PVC or CPVC to match piping wafer type for installation between flanges.
2. Disc: EPDM-coated steel.
3. Seats: PTFE.
4. Handle Style: Locking lever.
5. CWP Rating: Equal to piping service.
6. Maximum Operating Temperature: Equal to piping service.

E. Plastic Check Valves:
1. Body: One-, two-, or three-piece PVC or CPVC to match piping.
2. Ends: Socket or flanged.
3. Seats: PTFE.
4. Check Style: Swing or ball type.
5. CWP Rating: Equal to piping service.
6. Maximum Operating Temperature: Equal to piping service.

F. Bronze, Calibrated-Orifice, Balancing Valves:
1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig (860 kPa).
9. Maximum Operating Temperature: 250 deg F (121 deg C).

G. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.

3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Low inlet-pressure check valve.
7. Inlet Strainer: Removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

H. Diaphragm-Operated Safety Valves: ASME labeled.
1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Wetted, Internal Work Parts: Brass and rubber.
7. Inlet Strainer: Removable without system shutdown.
8.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

I. Automatic Flow-Control Valves:
1. Body: Brass or ferrous metal.
2. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
3. Combination Assemblies: Include bonze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

B. Expansion Tanks:
1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.
3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
4. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- (20-mm-) diameter gage glass, and slotted-metal glass guard.

C. In-Line Air Separators:
1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig (1207 kPa).
3. Maximum Operating Temperature: Up to 300 deg F (149 deg C).

2.4 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 60-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig (860 kPa).

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

C. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping."Section 15124 "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install throttling-duty calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.

D. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Close-coupled, end-suction centrifugal pumps.
3. Separately coupled, horizontally mounted, in-line centrifugal pumps.
4. Separately coupled, vertically mounted, in-line centrifugal pumps.
5. Separately coupled, base-mounted, end-suction centrifugal pumps.
6. Automatic condensate pump units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of pump.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-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 or vertically.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.

3. Pump Shaft: Steel, with copper-alloy shaft sleeve or stainless steel.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
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: Permanently lubricated ball bearings.

C. Motor: Single speed and rigidly 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."
    1)

    b. Efficiency: Premium efficient.
    c. Service Factor: 1.15

D. Capacities and Characteristics:

2.2 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve or stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

C. Motor: Single speed and rigidly mounted to pump casing with integral pump support.

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."

2.3 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. 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.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange 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 or stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

C. Shaft Coupling: Molded-rubber insert with interlocking spider capable of absorbing vibration.

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."

2.4 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. 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.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange 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 or stainless steel.

4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
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: Permanently lubricated ball bearings.

C. Shaft Coupling: Axially split spacer coupling.

D. 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."

2.5 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. 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.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange 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 or stainless steel.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT 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.

C. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

E. 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.

F. Motor: Single speed, secured to mounting frame, with adjustable alignment.

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."

2.6 AUTOMATIC CONDENSATE PUMP UNITS

A. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- minimum, electrical power cord with plug.

2.7 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 300-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. Angle or straight pattern.
2. 300-psig pressure rating, cast-iron body, pump-discharge fitting.
3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 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. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and elastomeric hangers, spring hangers spring hangers with vertical-limit stop of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.2 ALIGNMENT

A. Engage a factory-authorized service representative to 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.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties."

B. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to pump, allow space for service and maintenance.

D. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

E. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

F. Install check, shutoff, and throttling triple-duty valve on discharge side of pumps.

G. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps.

H. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

I. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

J. Install check valve and gate or ball valve on each condensate pump unit discharge.

K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty. Also include cleaning agents if reusing existing refrigerant piping.

B. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a shall meet manufacturer requirements or the following whichever is more strict:

1. Suction Lines for Air-Conditioning Applications: 115 psig.
2. Suction Lines for Heat-Pump Applications: 225 psig.
3. Hot-Gas and Liquid Lines: 225 psig.

B. Line Test Pressure for Refrigerant R-407C shall meet manufacturer requirements or the following whichever is more strict:

1. Suction Lines for Air-Conditioning Applications: 230 psig.
2. Suction Lines for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Liquid Lines: 380 psig.

C. Line Test Pressure for Refrigerant R-410A shall meet manufacturer requirements or the following whichever is more strict:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8/A5.8M.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and appropriate ac coil voltage.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Superheat: Adjustable.
6. Reverse-flow option (for heat-pump applications).
7. End Connections: Socket, flare, or threaded union.
8. Working Pressure Rating: 700 psig.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal or External.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and applicable voltage ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:
1. Body: Forged brass.

2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

2.4 REFRIGERANTS

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-134a

A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.3 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

G. Safety-Relief-Valve Discharge Piping: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

H. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

I. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

3.4 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Install a full-size, three-valve bypass around filter dryers.

D. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

E. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

F. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

I. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

J. Install receivers sized to accommodate pump-down charge.

K. Install flexible connectors at compressors.

3.5 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.7 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:

1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod, 1/2 inch.

D. Support multifloor vertical runs at least at each floor.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.9 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.10 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Flange connectors.
2. Duct-mounted access doors.
3. Flexible connectors.
4. Flexible ducts.
5. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inchminimum diameter for lengths 36 inchesor less; 3/8-inchminimum diameter for lengths longer than 36 inches

2.3 CONTROL DAMPERS

A. Frames:

1. Hat shaped.
2. 0.094-inch-ick, galvanized sheet steel.

B. Blades:

1. Multiple blade with maximum blade width of 6 inches
2. Parallel-blade design.
3. Galvanized-steel.
4. Blade Edging: Closed-cell neoprene.
5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

C. Blade Axles: 1/2-inch-ameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F

D. Bearings:

1. Dampers in ducts with pressure classes of 3-inch wgor less shall have axles full length of damper blades and bearings at both ends of operating shaft.
2. Thrust bearings at each end of every blade.

2.4 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gage and Shape: Match connecting ductwork.

2.5 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inchutt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 InchesSquare: No hinges and two sash locks.
    b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    c. Access Doors up to 24 by 48 Inches Three hinges and two compression latches.
    d. Access Doors Larger Than 24 by 48 Inches Four hinges and two compression latches with outside and inside handles.

2.6 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 incheswide attached to two strips of 2-3/4-inch-de, 0.028-inch-ick, galvanized sheet steel or 0.032-inch-ick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inchin the warp and 360 lbf/inchin the filling.
3. Service Temperature: Minus 40 to plus 200 deg F

2.7 FLEXIBLE DUCTS

A. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

B. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

C. Set dampers to fully open position before testing, adjusting, and balancing.

D. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. At outdoor-air intakes and mixed-air plenums.

E. Install access doors with swing against duct static pressure.

F. Access Door Sizes:

   1. One-Hand or Inspection Access: 8 by 5 inches
   2. Two-Hand Access: 12 by 6 inches
   3. Head and Hand Access: 18 by 10 inches
   4. Head and Shoulders Access: 21 by 14 inches
   5. Body Access: 25 by 14 inches
   6. Body plus Ladder Access: 25 by 17 inches

G. Label access doors to indicate the purpose of access door.

H. Install flexible connectors to connect ducts to equipment.

I. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.

END OF SECTION 233300

SECTION 233450 – BATHROOM EXHAUST FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes bathroom exhaust fans

1.2 SUBMITTALS

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

1. Include equipment, and indicate materials and finishes, dimensions, flow rates, and rated sound level for each type of fixture indicated.

1.3 COORDINATION

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

1.4 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. Exhaust Fans: 1 for every 100 of each type installed. Furnish at least one of each type.

1.5 GNERAL REQUIREMENTS

A. Basis-of-Design Product: These products are listed as examples that meet the performance specifications of the design. An alternate product that complies with all listed requirements for that fixture type shall be considered as comparable. It is the contractor's responsibility to ensure that the selected product – whether the example product or an alternate – is suitable for the existing conditions (wiring, dimensions, etc).

PART 2 - PRODUCTS

2.1 EXHAUST FAN **EF-1**

A. Performance Specification:

1. Energy Star certified product

2. CFM @ 0.10": 80 minimum

3. Rated sones: 0.8

4. No heater installed

5. No light bulb installed

6. UL Listed for use over baths and showers with a GFCI circuit

7. Basis-of-Design Product: Nutone AEN80

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set level, plumb, and square with ceiling.

B. Patch and paint to ensure exhaust fan retrofit maintains professional appearance.

C. It is the responsibility of the contractor to ensure the exhaust fans are installed according to the manufacturer recommendation and that they meet all code requirements.

3.2 FIELD QUALITY CONTROL

A. Testing for Exhaust Fans: Verify at least 50cfm of airflow.

END OF SECTION 233450

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes gas-fired, fire-tube, water-tube, water-jacketed condensing boilers, trim, and accessories for generating hot water.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, and mounting attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. Leakage and Materials: 10 years from date of Substantial Completion.
b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from date of Substantial Completion.

2. Warranty Period for Water-Tube Condensing Boilers: 20 years from date of Substantial Completion.

3. Warranty Period for Water-Jacketed Condensing Boilers:

    a. Leakage and Materials: Eight years from date of Substantial Completion.
    b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 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.

E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. CSA Compliance: Test boilers for compliance with CSA B51.

2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

A. 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.

B. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.

C. Pressure Vessel: Carbon steel with welded heads and tube connections.

D. Burner: Natural gas, forced draft.

E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors 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.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

2.3 WATER-TUBE CONDENSING BOILERS

A. Description: Factory-fabricated, -assembled, and -tested, copper-finned, 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.

B. Heat Exchanger: Finned-copper primary and stainless-steel secondary heat exchangers.

C. Combustion Chamber: Stainless steel, sealed.

D. Burner: Natural gas, forced draft drawing from gas premixing valve.

E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors 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.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

G. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.

H. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.

2.4 WATER-JACKETED CONDENSING BOILERS

A. 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.

B. Heat Exchanger: Stainless-steel primary and secondary combustion chamber.

C. Pressure Vessel: Carbon steel with welded heads and tube connections where not in contact with combustion or flue gases.

D. Burner: Natural gas, forced draft; swing-open front and burner observation port.

E. Blower: Centrifugal fan, forced draft. Include prepurge and postpurge of the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors 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.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.

G. Ignition: Electric-spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

2.5 TRIM

A. Aquastat Controllers: Operating, firing rate, and high limit.

B. Safety Relief Valve: ASME rated.

C. 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.

D. Boiler Air Vent: Automatic.

E. Drain Valve: Minimum NPS ¾ hose-end gate valve.

F. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.6 CONTROLS

A. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.

a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

C. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:

   a. Monitoring: On/off status, common trouble alarm low-water-level alarm.
   b. Control: On/off operation, hot-water-supply temperature set-point adjustment.

2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.7 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.
4. Provide each motor with overcurrent protection.

2.8 VENTING KITS

A. Kit: As specified by manufacturer.

B. Combustion-Air Intake: As specified by manufacturer.

2.9 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 2010 ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

A. Equipment Mounting:
   1. Comply with requirements for vibration isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

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.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."

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. Boiler Venting:

   1. Install flue venting kit and combustion-air intake.
   2. Connect full size to boiler connections.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Boiler will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 235216

SECTION 235223 – HEATING PLANT CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes heating plant controls and accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
1. Include control diagram indicating control wiring schematics.
2. Information indicating the specific location for the outside air temperature sensor and control panel(s), to be coordinated with the owner.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

B. Include final control diagram indicating control wiring schematics.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 ELECTRIC, FACTORY-FABRICATED AND FIELD-INSTALLED BOILER CONTROLLER

A. Boiler operating controls shall include the following devices and features:

1. Microprocessor control
2. Control transformer(s), where required.
3. Set-Point Adjust: Set points shall be adjustable.
4. 10K Thermistor Outdoor Air Temperature Sensors:
   a. Temperature Range: Minus 50°F to 140°F Probe: Single-point sensor with a stainless-steel sheath.
   b. Solar/Radiation Shield: UV Resistant
   c. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
   d. Conduit Connection: 1/2-inchtrade size.

5. Sequence of Operation Capability:
   a. The electric, factory-fabricated and field-installed boiler control shall, at a minimum, execute the following sequences of operation. Additionally, the following sequences, points lists and control diagram are for reference only. Any additional sequences and associated programming, control points and wiring required to execute the performance indicated in the specification or project scope outlined in the audit report shall be fully executed by the Contractor at no additional cost to the owner or project.
   b. The boiler plant shall maintain the heating water supply (HWS) temperature inversely with the outside-air temperature (OAT) per the suggested setpoints below.

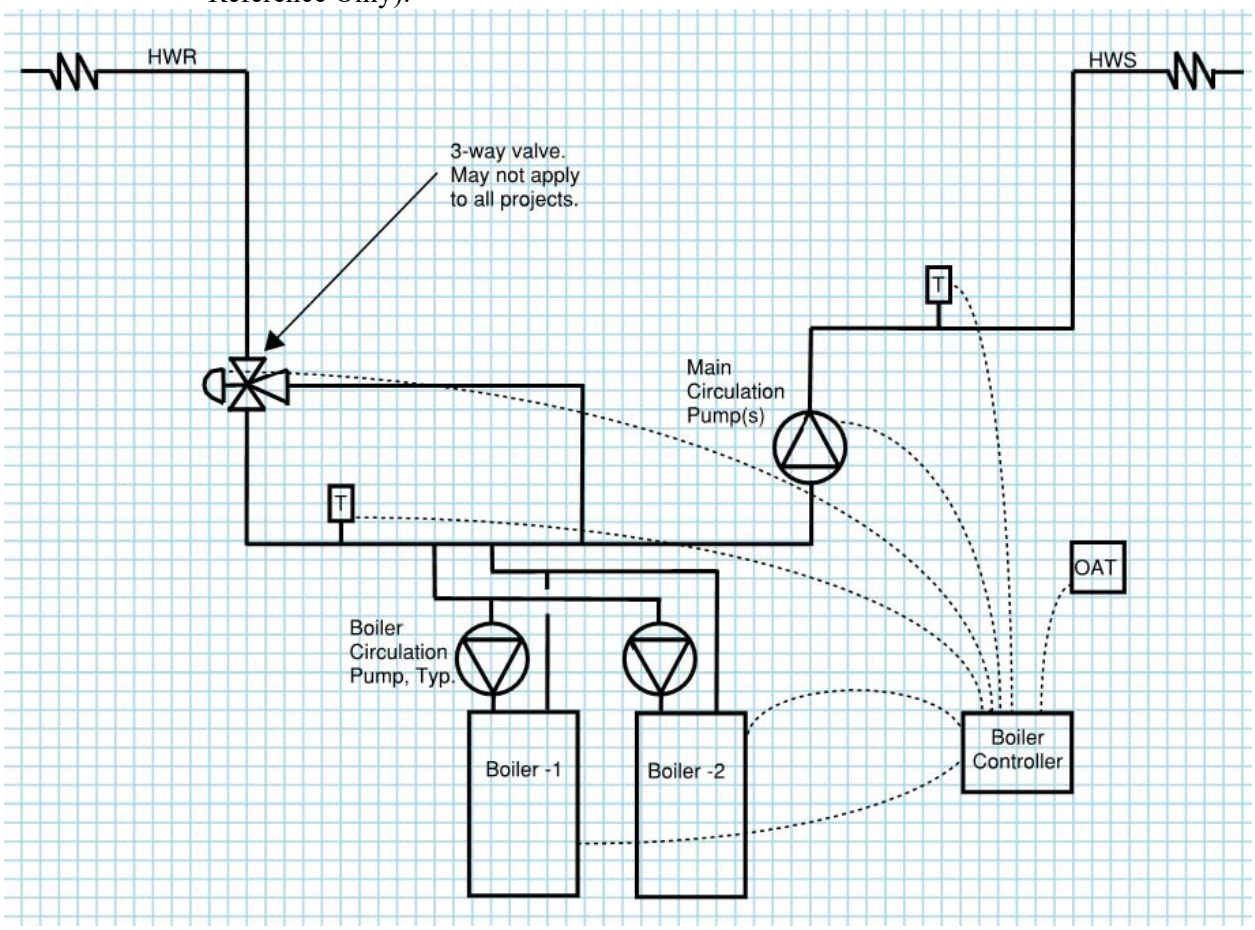
HWS Temperature Setpoint	Outside Air Temperature
180°F (adj.)	0°F (adj.)
160°F (adj.)	60°F (adj.)

   c. Outside Air Temperature Lockout/Warm Weather Shutdown: The boiler plant shall be enabled anytime the OAT less than 65°F (adj.).
   d. Boiler and boiler circulation pump enable/disable: Either enable the individual boiler controls, that in turn enable their boiler circulation pump, or enable the boiler and the boiler circulation pumps via the new factory-fabricated and field-installed boiler controller, as needed to maintain the HWS setpoint.
   e. Equal Runtime Boiler Rotation: Include automatic rotation of the boilers' lead and lag designations to even distribute run-time between each boiler in the plant. The rotation settings shall be adjustable at the new factory-fabricated and field-installed boiler controller.
   f. Minimum Boiler Return. Provide a new return sensor to monitor the heating water return (HWR) temperature to reduce boiler condensation and thermal shock. If the HWR temperature is less than 135°F (adj.), and the boiler plant is enabled, the boiler(s) shall continue to run until both the heating water supply temperature setpoint is satisfied and the HWR temperature is 140°F (adj.).
   g. Add Boiler Timer: The new factory-fabricated and field-installed boiler controller shall include an "Add Boiler Timer" to prevent short-cycling of the lag boiler. This timer shall lock-out the lag boiler for 15 minutes (adj.) after each time the lead boiler is enabled.
   h. Building Distribution Pump Enable / Disable: Provide a digital output to enable and disable each heating water building distribution pump. The pump shall be enabled anytime the plant is enabled.
   i. Alarms: If the existing boiler plant controls are capable of outputting a boiler failure alarm, the new factory-fabricated and field-installed boiler controller shall be capable of receiving the alarms, recognizing a boiler failure and enabling the lag boiler as needed.
6. New factory-fabricated and field-installed boiler controller Point List:

Point	AI	AO	DI	DO	Alarm	Notes:
Boiler Enable/Disable				X		Provide for each Boiler
Boiler Circulation Pump				X		Provide for each Boiler if not included in existing boiler controls
Building Distribution Pump Enable/Disable				X		
Building Heating Water Supply Temperature	X					

Point	AI	AO	DI	DO	Alarm	Notes:
Building Heating Water Return Temperature	X					
Outside Air Temperature	X					
Three-way valve control		X				Not applicable for all projects
Boiler Alarm			X			May not be applicable for all projects.
High CO			X			Disable

7. New factory-fabricated and field-installed boiler controller Control Diagram (For Reference Only):



2.3 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire size shall be at least No. 18 AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
4. Conductor colors shall be black (hot), white (neutral), and green (ground).

5. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable above 24 V:

1. Wire size shall be a minimum No. 18 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

C. Single Twisted Shielded Instrumentation Cable 24 V and Less:

1. Wire size shall be a minimum No. 18 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

2.4 RACEWAYS FOR CONTROL WIRING, CABLING, AND TUBING

A. Metal Conduits, Tubing, and Fittings:
1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. EMT: Comply with NEMA ANSI C80.3 and UL 797.
3. Fittings for Metal Conduit: Comply with NEMA ANSI FB 1 and UL 514B.
   a. Fittings for EMT:

      1) Material: Steel or die cast.
      2) Type: Setscrew or compression.

2.5 CONTROL POWER WIRING AND RACEWAYS

A. Low-Voltage Electrical Power Conductors and Cables shall be installed in accordance with all applicable codes and requirements of the Authorities Having Jurisdiction.

B. Raceways, cable trays, and other control power wiring shall be installed in a professional manner for cable runs, and not just run to complete works. Also, ensure that these components do not interfere with other disciplines.

2.6 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections shall be installed in accordance with all applicable codes and requirements of the Authorities Having Jurisdiction.

PART 3 - EXECUTION

3.1 INSTALLATION AND OPTIMIZATION

A. Install control wiring to field-mounted devices.

B. Install all wiring in EMT conduit per standard quality work practices.

C. The boiler controls shall be programmed by a factory-trained technician familiar and experienced with the product(s) being installed.

D. The boiler controls shall be setup and optimized per the characteristics of the existing boilers. For example, if the existing boiler has multiple stages, the boiler controller shall be programmed to utilize the boiler stages in the most efficient means as possible.

E. The Contractor shall coordinate with the owner to return to the project during warranty period to review the boiler setpoints on a cold weather day. The intent is to review the OAT reset setpoints, the boiler staging, etc. to ensure that the project has been properly setup over differing ambient conditions.

3.2 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain boiler controls.

END OF SECTION 235223

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.
d. Additional year of Parts and Labor warranty against failure caused by inadequate flushing of existing refrigerant piping including acid burn out of components.

PART 2 - PRODUCTS

2.1 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
6. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Filters: Permanent, cleanable.
9. Condensate Drain Pans:

a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 2 inches deep.

b. Single-wall, galvanized-steel sheet.
c. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

e. Pan-Top Surface Coating: Asphaltic waterproofing compound.
f. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Floor-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.

a. Discharge Grille: Steel with surface-mounted frame.
b. Insulation: Faced, glass-fiber duct liner.
c. Drain Pans: Galvanized steel, with connection for drain; insulated.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal, with power-induced outside air.
5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication unless otherwise stated in the report under proposed ECM.

6. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.
2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

1) Factory-fabricated, viscous-coated, flat-panel type.
2) Thickness: 1 inch or 2 inches.
3) Arrestance according to ASHRAE 52.1: 80.
4) Merv according to ASHRAE 52.2: 8.
5) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
6) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

C. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Enclosure Type: Totally enclosed, fan cooled.
d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
f. Mount unit-mounted disconnect switches on exterior of unit.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 1 inch deep.

b. Single-wall, galvanized-steel sheet.
c. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

e. Pan-Top Surface Coating: Asphaltic waterproofing compound.

8. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.
2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

2.2 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Scroll.
b. Refrigerant Charge: R-410A.
c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.

2.3 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Thermostat: Please reference narrative for individual requirements.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
1. Refer to Section 232300 “Refrigerant Piping” for TXV and refrigerant piping requirements.

E. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:
   1. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
   2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

   1. Water Coil Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."Section 15179 "Hydronic Piping Specialties." Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 260500 - ELECTRICAL POWER & LIGHTING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Surge Protection Devices
2. Low voltage power conductors and cables.
3. Raceway for electrical systems.
4. Lighting Control Devices.
5. Interior lighting fixtures, lamps, and drivers/ballasts.
6. Lighting fixture supports.
7. Retrofit kits for fluorescent lighting fixtures.
8. Exit signs.
9. Emergency lighting units.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CCT: Correlated color temperature.

D. CU: Coefficient of utilization.

E. Driver: Electronics components that couple to Light engine to convert power from line voltage AC to light engine operating mA output and voltage.

F. HID: High-intensity discharge.

G. LED: Light Emitting Diode

H. LER: Luminaire efficacy rating.

I. Light Engine: One or more LEDs coupled to a circuit board with or without on board optics.

J. Lumen: Measured output of lamp and luminaire; or both.

K. Luminaire: Complete lighting fixture, including driver/ballast housing if provided.

L. RCR: Room cavity ratio.

M. SPD: Surge Protection Device.

N. SVR: Suppressed Voltage Range.

1.4 SUBMITTALS

A. Surge Protection Device Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Low Voltage Power Conductors Product Data: For each type of product indicated.

C. Raceway for electrical systems Product Data: For each type of product indicated.

D. Lighting Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

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

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

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

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

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

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

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Fluorescent and/or LED and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. SPD Replaceable Protection Modules: One of each size and type installed.
2. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
3. LED replacement modules/boards: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
5. Battery and Charger Data: One for each emergency lighting unit.
6. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
7. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
8. Interior fixtures: 1 for every 100 of each type. Furnish at least one extra fixture of each interior fixture type (in addition to other extra materials described above).

PART 2 - PRODUCTS

2.1 SURGE PROTECTION DEVICES (SPD)

A. Not used for this project

2.2 LOW VOLTAGE POWER CONDUCTORS AND CABLES

A. Not used for this project

2.3 RACEWAYS FOR ELECTRICAL SYSTEMS

A. Note used for this project.

2.4 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Manufacturers: In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Basis-of-Design Product: These products are listed as examples that meet the performance specifications of the design. An alternate product that complies with all listed requirements for that fixture type shall be considered as comparable. It is the contractor's responsibility to ensure that the selected product – whether the example product or an alternate – is suitable for the existing conditions (dimensions, mounting type, bulb base type, etc).

B. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

C. LED Fixtures: 120-277VAC, 60hz driver power supply with 0-10V dimming capability, overload and short circuit protected. Test in accordance with IES LM79 and LM80.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

F. 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.

G. 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.

H. 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.

I. 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.

J. Factory-Applied Labels: Comply with UL 1598. Include recommended replacement LED light engines and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following LED light engine and driver characteristics:
      a. "USE ONLY" and include specific LED light engine type.
      b. Driver info including operating mA output and wattage.
      c. CCT and CRI for all luminaires.

2.5 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

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

2.6 LED LAMPS REPLACEMENT REQUIREMENTS

A. Solid State Lighting (LED) Sources must meet the following requirements:
   1. Lamp Efficacy: ≥ 85 lumens/watt
   2. CRI: ≥ 80
   3. CCT: 2700K for in-unit applications, 3000-3500K for common area applications, and 4000-5000K for exterior applications

4. Lumen Maintenance: 50,000+ hours, unless otherwise indicated. Details provided in "Requirements for Individual Lighting Fixtures"
5. LED Lamps: standard screw-in base, mercury free, CRI 80 (minimum), color temperature 2700K, minimum 5 year or 50,000 hour warranty, Energy Star labeled.
   a. 9.5W maximum for the replacement of CFLs with a wattage of 18W or lower, and for the replacement of incandescent bulbs with a wattage of 75W or lower.
   b. 17W maximum for the replacement of any CFLs higher than 18W and incandescent higher than 75W

2.7 LED FIXTURE REPLACEMENT REQUIREMENTS

A. Solid State Lighting (LED) Sources must meet the following requirements:
1. Fixture Efficacy: ≥ 90 lumens/watt.
2. CRI: ≥ 80
3. CCT: 2700K for in-unit applications, 3000-3500K for common area applications, and 4000-5000K for exterior applications
4. Lumen Maintenance: 50,000+ hours, unless otherwise indicated. Details provided in "Requirements for Individual Lighting Fixtures"
5. Warranty: 5+ years.

B. Power Supply Units (PSU) including drivers must meet the following requirements:
1. Must have a minimum efficiency of 85 percent
2. Must be rated to operate between -40°C to +50°C
3. Input Voltage: capable of 120 to 277 (±10%) volt, single phase as required by the site.
4. Power supplies can be UL Class I or II output.
5. Operating frequency must be 60 Hz.
6. Drivers must have a Power Factor (PF) of: ≥ 0.90.
7. Drivers must have a Total Harmonic Distortion (THD) of: ≤ 20%.
8. Drivers must comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards
9. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
10. Drivers for fixtures connected to dimmers must be compatible with specified dimming controls.
11. Driver Current Operation: Driver current to the LEDs shall range from 350mA to 1A (or per manufacturer's recommendation).

2.8 HEAT LAMPS

A. **Heat Lamp Type HL1:**

1. General Description: 125W incandescent heat lamp, infrared, BR40
2. Voltage: 120V
3. Basis-of-Design Product: Philips 046677416751

B. **Heat Lamp Type HL2:**

1. General Description: Recessed downlight enclosure with 125W incandescent heat lamp, infrared, BR40
2. Voltage: 120V
3. Lamp: Maximum 125 W, Incandescent Heat Lamp

4. Basis-of-Design Product: Progress Lighting P6952 series with Philips 046677416751 lamp
5. Additional Comments: Fixture shall be connected to a separate switch for on/off and/or timer switch control.

2.9 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

A. **Fixture Type FL1:**

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

B. **Fixture Type FL2:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 31 W, LED, 5000K, 2240 lumens at 73 lumens/watt, 70 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Special Conditions: Integrated motion sensor, preference for Energy Star qualified products.
7. Basis-of-Design Product: Cooper MST18920LES Motion LED twin head flood

C. **Fixture Type FL3:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 24 W, LED, 4000K, 2139 lumens, 70 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Special Conditions: Preference for Energy Star qualified products.
7. Basis-of-Design Product: Good Earth SE1038-TBZ-01LF0-E LED 2 light security light

D. **Fixture Type FL4:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 62 W, LED, 5000K, 7000 lumens, 70 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
7. Basis-of-Design Product: Cooper FFL-7L-50-UNV LED flood

E. **Fixture Type L1:**

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

F. **Fixture Type L1d:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 9 W, LED, 815 lumens, 80 CRI, 2700 K.
4. GU24 base
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Meets ANSI standards for A19 dimensions.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: GreenCreative A19 GU24 base LED

G. **Fixture Type L2:**

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

H. **Fixture Type L5a:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 8.5 W, LED, 80 CRI, 3000 K, minimum 800 lumens.
4. 2-pin base (replaces 2-pin CFL bulbs)
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Size and Lamp base: Contractor must verify dimensions of fixture and lamp base of fixture to ensure the retrofits will fit.
8. Meets ANSI standards for 2 Pin bulb dimensions.
9. Special Conditions: Preference for Energy Star qualified products.
10. Basis-of-Design Product: Philips 2 PIN LED lamps Series

I. **Fixture Type L5b:**

1. Performance Specification:

2. Voltage: 120V
3. Lamps: Maximum 8.5 W, LED, 80 CRI, 3000 K, minimum 800 lumens.
4. 4-pin base (replaces 4-pin CFL bulbs)
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Size and Lamp base: Contractor must verify dimensions of fixture and lamp base of fixture to ensure the retrofits will fit.
8. Meets ANSI standards for 4 Pin bulb dimensions.
9. Special Conditions: Preference for Energy Star qualified products.
10. Basis-of-Design Product: Philips 4 PIN LED lamps Series

J. **Fixture Type L5c:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 12 W, LED, 80 CRI, 3000 K, minimum 1300 lumens.
4. 4-pin base (replaces 4-pin CFL bulbs)
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Size and Lamp base: Contractor must verify dimensions of fixture and lamp base of fixture to ensure the retrofits will fit.
8. Meets ANSI standards for 4 Pin bulb dimensions.
9. Special Conditions: Preference for Energy Star qualified products.
10. Basis-of-Design Product: Philips 4 PIN LED lamps Series

K. **Fixture Type L5d:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 12 W, LED, 80 CRI, 3000 K, minimum 1300 lumens.
4. 2-pin base (replaces 2-pin CFL bulbs)
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Size and Lamp base: Contractor must verify dimensions of fixture and lamp base of fixture to ensure the retrofits will fit.
8. Meets ANSI standards for 2 Pin bulb dimensions.
9. Special Conditions: Preference for Energy Star qualified products.
10. Basis-of-Design Product: Philips 2 PIN LED lamps Series

L. **Fixture Type L6:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 7 W, LED, 90 CRI, 2700 K.
4. Candelabra bulb replacement
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Meets ANSI standards for A21 dimensions.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Cree B13 LED candelabra lamps

M. **Fixture Type L7:**

1. Performance Specification:
2. Voltage: 120V
3. Lamps: Maximum 10.2 W, LED, 815 lumens, 80 CRI, 5000 K
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Meets ANSI standards for A19 dimensions.
7. Special Conditions: Preference for Energy Star qualified products
8. Basis-of-Design Product: CREE A19 LED

N. **Fixture Type L10a:**

1. Performance Specification:
2. Voltage: 100-277V
3. Lamps: 24W LED, 4000K, 165 lumens per watt
4. Bulb should be designed to replace HID/HPS bulb
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Size and Lamp base: Contractor must verify dimensions of fixture and lamp base of fixture to ensure the retrofits will fit.
8. Special Conditions: Preference for Energy Star qualified products
9. Basis-of-Design Product: Truly Green Solutions Universal Light

O. **Fixture Type L10b:**

1. Performance Specification:
2. Voltage: 100-277V
3. Lamps: 36W LED, 4000K, 165 lumens per watt
4. Bulb should be designed to replace HID/HPS bulb
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Size and Lamp base: Contractor must verify dimensions of fixture and lamp base of fixture to ensure the retrofits will fit.
8. Special Conditions: Preference for Energy Star qualified products
9. Basis-of-Design Product: Truly Green Solutions Universal Light

P. **Fixture Type L10c:**

1. Performance Specification:
2. Voltage: 100-277V
3. Lamps: 54W LED, 4000K, 165 lumens per watt
4. Bulb should be designed to replace HID/HPS bulb
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Size and Lamp base: Contractor must verify dimensions of fixture and lamp base of fixture to ensure the retrofits will fit.
8. Special Conditions: Preference for Energy Star qualified products
9. Basis-of-Design Product: Truly Green Solutions Universal Light

Q. **Fixture Type L10d:**

1. Performance Specification:
2. Voltage: 100-277V
3. Lamps: 150W LED, 4000K, 140 lumens per watt
4. Bulb should be designed to replace HID/HPS bulb
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Size and Lamp base: Contractor must verify dimensions of fixture and lamp base of fixture to ensure the retrofits will fit.
8. Special Conditions: Preference for Energy Star qualified products
9. Basis-of-Design Product: GE LED HID Type B Replacement Lamps

R. **Fixture Type LC1:**

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

S. **Fixture Type LC2:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: Surface Ceiling/Canopy
4. Lamps: 4000K, LED unit, maximum 17W, 85 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 17W input driver.
7. Lumens: Minimum of 1,029 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Special Conditions: Preference for Energy Star qualified product.
10. Basis-of-Design Product: Lithonia OLCFM ceiling/canopy LED fixture

T. **Fixture Type LC3:**

1. Performance Specification:
2. Voltage: Universal (120-277V)
3. Mounting: Surface Ceiling
4. Lamps: 4000K, LED unit, maximum 11W, 74 CRI.
5. Driver Type: Weather tight, class 2, 11W input driver.
6. Lumens: Minimum of 900 lumens
7. External Finish: Grid style.
8. Special Conditions: Preference for Energy Star qualified product.

9. Basis-of-Design Product: Inter-Global FE112 LED Nautical Oval Wall Lantern (HD supply # 504443)

U. **Fixture Type LC4:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: Surface Ceiling
4. Lamps: 5000K, LED unit, maximum 9W.
5. Driver Type: Weather tight, 9W input driver.
6. Lumens: Minimum of 700 lumens
7. External Finish: Black steel housing with frosted glass lens.
8. Special Conditions: Preference for Energy Star qualified product.
9. Basis-of-Design Product: Seasons OCFW70050LBK-50 (HD supply # 326807)

V. **Fixture Type P1a:**

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

W. **Fixture Type P1b:**

1. Performance Specification:
2. Voltage: Universal (120-277V)
3. Mounting: Versatile mount arm. Arm mounted at top of existing pole (replacing 100-200W HPS or MH). Verify pole type and shape (square vs round).
4. Lamps: 4,000K, maximum 96W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, THD less than 20 percent.
6. Lumens: 10,000 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
10. Basis-of-Design Product: Eaton Cooper Lighting GLEON Galleon

X. **Fixture Type P1c:**

1. Performance Specification:
2. Voltage: Universal (120-277V)

3. Mounting: Versatile mount arm. Arm mounted at top of existing pole (estimate 20'-25' pole height, replacing 200-400W HPS or MH). Verify pole type and shape (square vs round).
4. Lamps: 4,000K, maximum 166W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, THD less than 20 percent.
6. Lumens: 18,000 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
10. Basis-of-Design Product: Eaton Cooper Lighting GLEON Galleon

Y. **Fixture Type P2b:**

1. Performance Specification:
2. Voltage: Universal (120-277V)
3. Mounting: Versatile mount arm. Arm mounted at top of existing pole (replacing 100-400W HPS or MH). Verify pole type and shape (square vs round). **Compatible for mounting multiple heads on same pole.**
4. Lamps: 4,000K, maximum 96W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, THD less than 20 percent.
6. Lumens: 10,000 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
10. Basis-of-Design Product: Eaton Cooper Lighting GLEON Galleon

Z. **Fixture Type P2c:**

1. Performance Specification:
2. Voltage: Universal (120-277V)
3. Mounting: Versatile mount arm. Arm mounted at top of existing pole (estimate 20'-25' pole height, replacing 200-400W HPS or MH). Verify pole type and shape (square vs round). **Compatible for mounting multiple heads on same pole.**
4. Lamps: 4,000K, maximum 166W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, THD less than 20 percent.
6. Lumens: 18,000 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
10. Basis-of-Design Product: Eaton Cooper Lighting GLEON Galleon

AA. **Fixture Type RL4:**

1. Performance Specification:
2. Voltage: Universal (120-277V)

3. 2’ T8 replacement lamps
4. Lamps: LED, maximum 8 W, CRI >80, 3500K
5. Driver Type: Remote, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Ensure bulb compatibility with existing fixture. Preference for Energy Star qualified products.
8. Basis-of-Design Product: GE Type C LED Tubes with remote dedicated LED driver

BB. **Fixture Type RL5:**

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

CC. **Fixture Type RL6:**

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

DD. **Fixture Type RL7:**

1. Performance Specification:
2. Voltage: Universal (120-277V)
3. 8’ T8 replacement lamps
4. Lamps: LED, maximum 30 W, CRI >80, 3500K
5. Driver Type: Remote, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Ensure bulb compatibility with existing fixture. Preference for Energy Star qualified products.
8. Basis-of-Design Product: GE Type C LED Tubes with remote dedicated LED driver

EE. **Fixture Type RO2:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: flush, round – contractor should confirm diameter is equal to or greater than existing fixture, or that space around the mounted new fixture is cleaned up (spackled, painted, etc)

4. Lamps: LED, 14W, minimum 1000 lumens, 80+ CRI
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.
8. Basis-of-Design Product: Metalux AP series 12" LED flush round mount

FF. **Fixture Type RO3:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: flush, round – contractor should confirm diameter is equal to or greater than existing fixture, or that space around the mounted new fixture is cleaned up (spackled, painted, etc)
4. Lamps: LED, 22W, minimum 1700 lumens, 80+ CRI
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.
8. Basis-of-Design Product: Metalux AP series 16" LED flush round mount

GG. **Fixture Type RO4:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: flush, round – contractor should confirm diameter is equal to or greater than existing fixture, or that space around the mounted new fixture is cleaned up (spackled, painted, etc)
4. Lamps: LED, 32W, minimum 1000 lumens, 80+ CRI
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.
8. Basis-of-Design Product: Metalux AP series 20" LED flush round mount

HH. **Fixture Type RR2:**

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

II. **Fixture Type RR3:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: 2' x 4' recessed
4. Lamps: LED, maximum 36 W, 4300 lumens, 80 CRI, 3500K
5. Driver Type: Integral, high efficiency.

6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.
8. Basis-of-Design Product: Philips 2FG-G-43L-835-4-STANDARD LENS-UNV-DIM

JJ. **Fixture Type RR4:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: 2’ x 4’ recessed
4. Lamps: LED, maximum 49 W, 5400 lumens, 80 CRI, 3500K
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.
8. Basis-of-Design Product: Philips 2FG-G-54L-835-4-STANDARD LENS-UNV-DIM

KK. **Fixture Type RR5:**

1. Performance Specification:
2. Voltage: Universal (120-227V)
3. Mounting: 2’ x 2’ recessed ceiling troffer
4. Lamps: LED, maximum 30 W, CRI >80, 3500K, 3292 lumens
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.
8. Basis-of-Design Product: Metalux 22CZ Cruze Series 22CZ-LD5-34-UNV-L830-CD1-U

LL. **Fixture Type RR6:**

1. Performance Specification:
2. Voltage: Universal (120-227V)
3. Mounting: 2’ x 2’ surface flush mount
4. Lamps: LED, maximum 32 W, CRI >80, 3500K, 3400 lumens
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.
8. Basis-of-Design Product: Metalux 22SP3435 LED

MM. **Fixture Type RS1:**

1. Performance Specification:
2. Voltage: 120V
3. Fixture type: 18” under-cabinet fixture
4. Mounting: Under-cabinet
5. Lamps: LED, maximum 8 W, CRI > 80, 2700K
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Eaton Cooper HU1024D930P + HU109P series

NN. **Fixture Type RS1b:**

1. Performance Specification:
2. Voltage: 120V

3. Fixture type: 24” under-cabinet fixture
4. Mounting: Under-cabinet
5. Lamps: LED, maximum 11 W, CRI > 80, 2700K
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Eaton Cooper HU1024D930P + HU109P series

OO. **Fixture Type RS2:**

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

PP. **Fixture Type RS3:**

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

QQ. **Fixture Type RS4:**

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

RR. **Fixture Type RS6:**

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

SS. **Fixture Type RW1:**

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

TT. **Fixture Type RW2:**

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

UU. **Fixture Type RW3:**

1. Performance Specification:
2. Voltage: Universal (120-277 V)
3. Fixture type: 4’ surface mount wide wrap fixture
4. Mounting: Contractor should ensure that if new fixture is narrower than existing fixture, space around the mounted new fixture is cleaned up (spackled, painted, etc)
5. Lamps: LED, maximum 50 W, 80 CRI, 3500 K, 6000 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Lithonia LBL4W series

VV. **Fixture Type RW4:**

1. Performance Specification:
2. Voltage: Universal (120-277 V)
3. Fixture type: 2’ surface mount wrap fixture
4. Mounting: Contractor should ensure that if new fixture is narrower than existing fixture, space around the mounted new fixture is cleaned up (spackled, painted, etc)
5. Lamps: LED, maximum 25 W, 80 CRI, 3500 K, 2800 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Eaton Cooper 2WNLED-LD4-28SL-F-UNV-L835

WW. **Fixture Type V1:**

1. Performance Specification:
2. Voltage: Universal (120-277 V)
3. Fixture type: 2’ wall mount vanity fixture
4. Mounting: Contractor should ensure that if new fixture is narrower/shorter than existing fixture, space around the mounted new fixture is cleaned up (spackled, painted, etc)
5. Lamps: LED, maximum 18 W, 90 CRI, 3000 K, 1300 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Lithonia FMVTSL-24IN

XX. **Fixture Type V2:**

1. Performance Specification:
2. Voltage: Universal (120-277 V)
3. Fixture type: 4’ wall mount vanity fixture
4. Mounting: Contractor should ensure that if new fixture is narrower/shorter than existing fixture, space around the mounted new fixture is cleaned up (spackled, painted, etc)
5. Lamps: LED, maximum 34 W, 90 CRI, 3000 K, 2500 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Lithonia FMVTSL-48IN

YY. **Fixture Type WL1:**

1. Performance Specification:
2. Voltage: Universal 120-227V
3. Mounting: Surface wall or ground mounted, consistent with existing fixture
4. Lamps: 4000K, LED unit, maximum 51W, 73 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 51W input driver.
7. Lumens: Minimum of 1,884 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.

10. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
11. Basis-of-Design Product: Cooper Lighting Lumark NFFLD-S series

ZZ. **Fixture Type WP2b:**

1. Performance Specification:
2. Voltage: Universal 120-227V
3. Mounting: Surface Wall
4. Lamps: 5000K, LED unit, maximum 28W, 70 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 28W input driver.
7. Lumens: Minimum of 3,400 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.
10. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
11. Basis-of-Design Product: Lithonia TWR1 LED Wall Luminaire series

AAA. **Fixture Type WP3b:**

1. Performance Specification:
2. Voltage: Universal 120-227V
3. Mounting: Surface Wall
4. Lamps: 5000K, LED unit, maximum 62W, 70 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 62W input driver.
7. Lumens: Minimum of 5,500 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.
10. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
11. Basis-of-Design Product: Lithonia TWR1 LED Wall Luminaire series

BBB. **Fixture Type WP4:**

1. Performance Specification:
2. Voltage: Universal (120-277V)
3. Mounting: Surface Wall
4. Lamps: 4000K (5000K is acceptable), LED unit, maximum 25W, 70 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, high efficiency, 25W input driver.
7. Lumens: Minimum of 2,700 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
10. Basis-of-Design Product: Morris #71525A Mini Wall Pack LED

CCC. **Fixture Type WP5:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: Surface Wall
4. Lamps: 4000K, LED unit, maximum 9W, 80 CRI.
5. Driver Type: Weather tight, high efficiency, 25W input driver.
6. Lumens: Minimum of 630 lumens
7. External Finish: Decorative lantern style.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Morris #72134 LED Ornamental Entryway Light series

DDD. **Fixture Type WP6:**

1. Performance Specification:
2. Voltage: 120V
3. Mounting: Surface Ceiling or Wall
4. Lamps: 5000K, LED unit, maximum 10W, 70 CRI.
5. Driver Type: Weather tight, high efficiency, 25W input driver.
6. Lumens: Minimum of 845 lumens
7. External Finish: Caged glass lens.
8. Special Conditions: Preference for Energy Star qualified products.
9. Basis-of-Design Product: Morris #72105 LED VaporTight Jelly Jars

EEE. **Fixture Type WP7:**

1. Performance Specification:
2. Voltage: Universal (120-277V)
3. Mounting: Surface Wall
4. Lamps: 5000K, LED unit, maximum 9W, 80 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, high efficiency, 9W input driver.
7. Lumens: Minimum of 1,000 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
10. Basis-of-Design Product: Morris #71593 Mini Wall Pack LED

FFF. **Fixture Type WP8:**

1. Performance Specification:
2. Voltage: Universal 120-227V
3. Mounting: Surface Wall
4. Lamps: 5000K, LED unit, 20W, 70 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, 20W input driver.
7. Lumens: Minimum of 2,000 lumens
8. External Finish: Manufacturer's standard finish option per site. Quarter sphere.

9. Special Conditions: Integral photocell unless fixture is served by central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.
10. Basis-of-Design Product: McGraw-Edison ISS Impact Elite LED Small Quarter Sphere

GGG. **Fixture Type WS1:**

1. Performance Specification:
2. Voltage: Universal (120-277V)
3. Lamps: Maximum 10W, LED, 3000K, 790 lumens at 79 lumens/watt, 80 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Trim and Finish: Brushed Nickel
7. Special Conditions: Preference for Energy Star qualified products.
8. Basis-of-Design Product: Seasons LED Saturn Wall Sconce (model # 39110000)

HHH. Fixture Type X1 (exit sign):

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

2.10 INSTALLATION

A. Surge Protection Device: Not used for this project

B. Low-voltage power conductors and cables: Not used for this project

C. Raceway Application: Not used for this project

D. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
1. Patch and paint to ensure fixture retrofit maintains professional appearance.
2. It is the responsibility of the contractor to ensure the fixtures are installed according to the manufacturer recommendation and that they meet all code requirements.

2.11 FIELD QUALITY CONTROL

A. Testing for Surge Protection Devices: Not used for this project

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

END OF SECTION 260500

MINIMUM SOLAR TECHNICAL SPECIFICATIONS

Part 1 - GENERAL

1.01 Design

System electrical and structural design documents shall be prepared, stamped, and signed by an engineer licensed in the State of Texas. Any paperwork required for rebates shall be submitted by the installer. The project consists of installing a roof mounted solar photovoltaic system.

System design documents shall include, but not be limited to, the following:

1. Site plan
2. Any planned civil work onsite
3. Conceptual plan/system layout
4. System schematics
5. System capacity calculations
6. Single line electrical diagram for PV system
7. DC and AC schematics for equipment that connects to SAHA's electrical system
8. Construction plans (structural, civil, mechanical, etc.).
9. Racking and mounting details
10. Wind and snow loading and any required seismic calculations
11. List of equipment and materials schedule, including:
12. Solar photovoltaic modules
13. Inverters
14. Racking
15. Balance of systems equipment
16. Manufacturer's data and cut sheets on solar photovoltaic modules, inverters, racking and balance of systems equipment.
17. Construction specifications (including commissioning plan).

Developer agrees to design and construct the System in accordance with all applicable building codes and standards. System design documents will expressly identify the applicable building codes and standards. The system design (and installation) documents shall be made available to

SAHA and/or its representative for review and acceptance. The Developer shall allow sufficient time in the project schedule for this review to take place.

The Developer shall:

1. Complete the design for all elements of the project, including but not limited to: civil, structural, architectural, mechanical, electrical, and specialty consulting areas.

2. Incorporate the requirements of permitting agencies as may become apparent in the course of design.

1.02 Construction

The Developer shall:

1. Provide weekly updates, as necessary, to SAHA for schedule tracking, status updates and to highlight technical issues.

2. Provide complete management, supervision, and reporting of all aspects of the construction of this Project.

3. Provide resident engineering and contract administration, and inspections, including special inspections, necessary for the functional, safe, and on-schedule completion of the Project. SAHA or its representative shall be allowed to perform inspections to verify compliance with the Contract Documents.

4. Ensure compliance with applicable local, state, and federal codes, building and environmental permit requirements and enforcement of the Contract Documents.

5. Report accidents, claims, and other on-going safety related issues to SAHA within twenty-four hours.

6. Adhere strictly to construction access requirements as established by SAHA during the entire length and scope of the project construction. This shall include the Developer, its employees, contractors, and/or agents.

7. Ensure all applicable and required forms of insurance and limits to liability are acquired by the Developer prior to commencement of construction.

As part of the closeout process, prior to Final Completion of the system, the Developer shall:

1. Conduct a walk-through with SAHA to generate a complete punch list (at Substantial Completion), address all comments on punch list, and confirm all items are complete at Final Completion. SAHA and the commissioning agent shall have the opportunity to observe and verify the PV system's performance. SAHA may request specific tests or commissioning checks related to the interconnection site before project acceptance.

2. Administer and coordinate the project contract closeout process and resolve any warranty provision issues.

3. Report progress of project construction contract closeout to SAHA.

1.02 Solar PV System Installation

The Developer shall provide the labor necessary to install all solar PV equipment, materials, and components to interconnect to the point-of-interconnection with SAHA and the appropriate Utility.

Installation must comply with the following codes, regulations, and requirements:

1. PV systems must be installed in compliance with all applicable state building codes including OSHA and the Texas and San Antonio Building and Fire Codes.

2. PV system must be installed in compliance with all applicable local building codes, including the National Electrical Code:

    a. Article 690 -Solar Photovoltaic Systems

All Balance of System (wiring, component, wiring, conduits, and connections) must be suited for conditions for which they are to be installed.

1.03 Interconnection

The Developer shall supply, install, and deliver all solar PV equipment required to interconnect to appropriate Utility. The Developer shall fulfill all procedures to complete the interconnection process. Interconnection standards shall comply with all applicable codes and regulations.

1.04 Operation & Maintenance Manuals and Record Documents

Developer shall provide to SAHA site-specific operation, maintenance, and parts manuals for the installed solar PV system. These O&M Manuals shall cover all components, options, and accessories supplied. The Manuals shall include maintenance, trouble-shooting, and safety precautions specific to the supplied equipment at the site. A PDF copy of the O&M Manual is required in addition to the hard copies. The Developer shall also provide one (1) sets of Record Documents in both PDF and AutoCAD 14 or higher (for drawings) and both PDF and Microsoft Word (for specifications). These requirements shall be delivered within six (6) weeks of Commercial Operation.

The developer shall also provide the authority with training on the monitoring of the solar PV system.

END OF SPECIFICATION

Exhibit C

General Contract Administration and Commissioning Requirements

Construction Administration Requirements include but are not limited to:

- Assist in pre-construction coordination activities
- Represent the owner, architectural, energy savings, and engineering interests throughout the course of construction phase;
- Attend and participate in Owner, Architect, and Contractor Meetings ("OAC") as required.
- Review and approve submittals and design documents to ensure they are in accordance with project specifications, design intent, applicable for utility rebate programs (if applicable), and meet energy and water performance specifications
- Review, comment, process, and or approve all submittals, design documents, RFI's, Pay Applications, Change Orders, addendums, ASI's, and other construction documents as required.
- Bring to the attention of the Owner any significant changes to the program of the project or items that will result in a Change Order or change in energy/water efficiency performance;
- Advise SAHA on all necessary Change Orders Requests and provide cost reasonableness when processing each Change Order pursuant to HUD's Procurement Procedures Title 2 Code of Federal Regulations Part 200.317-200.326;
- Provide primary oversight and responsibility to capture all available incentives and rebates from local utilities and other sources
- Provide quality control and site inspections required by project lender, HUD, and SAHA prior to each pay application approval
- Perform punchlist - walks of work completed and ensure appropriate owner maintenance training are being conducted and Operations & Maintenance manuals are delivered.

Commissioning Agent Requirements include but are not limited to:

SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Commissioning Plan prepared by the CxA contains requirements that apply to this Section.

1.2 SUMMARY

A. This Section includes general requirements that apply to implementation of commissioning without regard to specific systems, subsystems, and equipment being commissioned.

B. Owner has employed an independent Commissioning Authority (CxA). The Commissioning Authority is an independent and knowledgeable third party, hired to verify that the systems being commissioned work as intended. The Commissioning Authority will inform the Owner of the results of the Commissioning Process and provide suggestions, as necessary, to correct deficiencies in observed performance or installation.

C. The Commissioning Process is a quality-oriented process for achieving, verifying and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.

D. The Contractor is responsible for participation in the Commissioning Process as outlined in the Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections; the *Commissioning Plan*.

E. The *Commissioning Plan* provides specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

F. The Contractor is responsible to furnish labor and materials sufficient to meet all requirements of building commissioning under this contract.

1.3 SYSTEMS-TO-BE-COMMISSIONED

A. Central Plant Retrofits and Optimization

B. Solar PV

C. “Focused, Quality-Based Sampling” of Typical, Non Major ECMs
   1. In-unit Lighting Retrofits
   2. Heat Lamps
   3. Common Area Lighting Retrofit
   4. Exterior Lighting Retrofit

5. Exhaust Fans
6. Window Replacement
7. Furnaces
8. Heat Pumps
9. Low Flow Aerator Installations
10. Low Flow Showerhead Installations
11. Low Flow Water Closet Flush Valve Retrofits

D. There may be additional commissioning requirements in the San Antonio Housing Authority EPC Phase II Investment Grade Audit. All requirements and ECMs listed in the Audit apply to this project.

1.4 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Deficiency: Installation or remediation effort, or a portion thereof, that lacks in workmanship, quality and directly invalidates or compromises the energy performance of the energy conservation measure as identified in the *San Antonio Housing Authority EPC Phase II Investment Grade Audit*.
1. The Commissioning Authority and Owner shall be the sole authorities in determining what does or does not constitute as a deficiency in installation or remediation.

D. ECM: Energy Conservation Measure

E. Focused, Quality-Based Sampling: Commissioning effort intended to review a set percentage of typical installation and/or remediation efforts at a limited number of typical locations and types.

F. Functional Performance Testing (FPT): The testing of the dynamic function and operation of components, equipment and systems using manual (direct observation) and monitoring (data-logging/trending) methods.

G. Functional Performance Test procedure: A written protocol that defines methods, steps, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

H. Major Equipment Retrofits: Work associated with the Central Plant Retrofits & Optimization, Windows, and Roof Replacement with solar PV as identified and described in the *San Antonio Housing Authority EPC Phase II Investment Grade Audit*.

I. M&V: Measurement and Verification

J. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

K. Pre-Functional Checklist (PFC): A form used by the Contractor to verify that appropriate components are onsite, ready for installation, correctly installed, set up, calibrated and functional.

L. Quality Based Sampling: A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.

M. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

N. TAB: Testing, Adjusting and Balancing.

O. Typical, Non-Major: Energy Conservation Measures that require multiple installations or remediates executed in a typical fashion with each individual installation representing a non-major portion of a larger and major anticipated energy savings as described and identified in the *San Antonio Housing Authority EPC Phase II Investment Grade Audit*.

1.5 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
   1. Architect and engineering design professionals as required for complete implementation of ECMs.

B. Commissioning Coordinator Supervisor: The General Contractor shall provide a person with at least five (5) years of experience with the coordination of disciplines of construction. This person does not necessarily need to be fully dedicated to this role, but the Coordinator's responsibilities shall, at a minimum, include:
   1. Cx Coordination meetings.
   2. Cx Planning.
   3. Cx Scheduling.
   4. Cx Documentation.
   5. Communication with the Commissioning Authority.
   6. Coordination and completion of Cx-related corrective actions.
   7. Owner Training.

C. Members Appointed by Owner:

   1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
   2. Representatives of the facility user and operation and maintenance personnel.

1.6 DOCUMENT SUBMISSION REQUIREMENTS

A. Provide a comprehensive submittal log of all submittals to the Commissioning Authority prior to submission of any equipment submittals for review.
   1. From the submittal log, the Commissioning Authority will identify which submittals shall be presented to the CxA for review and comment.
   2. The Commissioning Authority shall receive and review the submittals concurrent with the Owner.

B. Master Construction Schedule: Coordinate with the CxA the scheduling of the commissioning process with regards to timing and duration of the commissioning tasks and milestones. Including but not limited to, equipment start-up; testing, adjusting and balancing; functional performance testing and Owner training sessions.

C. Submit a copy of Construction Meeting Minutes; Requests for Information (RFI); Requests for Proposals (RFP) for construction, engineering and architectural services; Change Orders (CO); etc. to the CxA as they occur.

D. Submit training session plans to the CxA for approval after receiving the approved submittal for systems. See Part 3 below for training plan requirements. CxA will coordinate Owner approval of submitted training plans.

E. Contractor is required to submit the operation and maintenance manuals to the CxA and Owner for review within two (2) weeks after receiving the approved submittal for systems. Following review and approval process, submit final operations and maintenance manuals no later than two (2) weeks prior to the commencement of training.

F. Submit completed Pre-Functional and Startup Checklists to CxA within a minimum of one (1) week prior to scheduled Functional Performance Testing.

G. Submit Functional Performance Testing schedule to the CxA at least two (2) weeks prior to the start of testing.

H. Submit the Test and Balance Execution Plan to the Owner and CxA for review and approval no later two (2) weeks prior to the commencement of balancing.

I. Submit the completed preliminary test and balance reports to the Owner and CxA for review and approval within one (1) week of completion of work; and prior to commencement of HVAC system Functional Performance Tests. Legible, hand written, field generated test and balance reports are considered acceptable preliminary reports. Provide written documentation that all deficiency items identified in the preliminary test and balance report(s) have been addressed, or provide a schedule identifying when each item will be addressed. This shall include a schedule for when any additional testing, adjusting and balancing will be completed following corrective measures being completed.

J. System Functional Performance Testing will start only after the successful balance report is reviewed and accepted.

1.7 OWNER'S RESPONSIBILITIES

A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
   1. Coordination meetings.
   2. Making personnel available for training in operation and maintenance of systems, subsystems, and equipment.
   3. Testing meetings.
   4. Inspection and review of mock-ups and installations.
   5. Demonstration of operation of systems, subsystems, and equipment.

1.8 CONTRACTOR'S RESPONSIBILITIES

A. Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

   1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
   2. Cooperate with the CxA for resolution of issues recorded in the Issues and Benefits Log.
   3. Attend commissioning team meetings held on an as needed basis.
   4. Integrate and coordinate commissioning process activities with construction schedule.
   5. Review and accept pre-functional checklists provided by the CxA.
   6. Complete paper or electronic pre-functional checklists as Work is completed and provide to the Commissioning Authority prior to Functional Performance Testing.
   7. Review and accept commissioning functional performance test procedures provided by the Commissioning Authority.
   8. Complete commissioning functional performance test procedures.
   9. Provide to the CxA copies of all submittals and shop drawings, manufacturer's literature, maintenance information or other information as may be needed for systems to be commissioned.
   10. Provide the CxA with any requested documentation prior to, or in addition to, the O&M Manual submittals requirements outlined in other specification sections.
   11. Assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings, or equipment documentation is not sufficient for writing detailed functional performance testing procedures.
   12. Develop a full start-up and initial checkout plan using manufacturer’s start-up procedures and related specification sections.
   13. Provide updates to all project documentation to reflect all supplemental instructions, addenda or other modifications to the Contract Documents. Updates and supplemental instructions must be posted to the master set of Contract Documents for review and reference by all contractors, sub-contractors, and system component suppliers, and for the CxA's use.
   14. Provide qualified and trained personnel to participate in the commissioning process.
   15. Review the Cx Plan, Cx Issues and Benefits Logs, and project correspondence. In a timely manner, respond to the CxA and address the identified issues.
   16. Issue a written Notice of Readiness for each system to CxA upon completion of all systems work, start-up and Pre-functional Tests Checklists requirements by trade contractors.

17. Test all equipment and systems using the Functional Performance Test procedures *PRIOR TO DEMONSTRATING PROPER PERFORMANCE TO THE CXA*.
    a. Contractor is responsible for completing Functional Performance Testing. CxA is responsible for verifying Functional Performance Testing.
18. Operate equipment and systems as required for Functional Performance verification by CxA. This includes manipulating the temperature controls to execute the Functional Performance Test Procedures.
19. Participate in the fine-tuning or troubleshooting of system performance, if either of these measures becomes necessary.
20. Readiness
    a. It is the obligation of all parties to be prepared for commissioning activities. Prior to commencement of Functional Performance Testing the Contractor shall ensure completion of the following items as they relate to the equipment and/or system being commissioned:
        1) Permanent utility and central plant connection to the equipment/system.
        2) Completed equipment/system startup documentation has been delivered to the Commissioning Authority.
        3) Written notification from the responsible Contractor to the Commissioning Agent stating completion of equipment/system startup documentation
    b. It is at the sole discretion of the Commissioning Authority to begin Functional Performance Testing without one or more of the aforementioned items completed. If the aforementioned items will not be completed prior to the mutually agreed upon start date for Functional Performance Testing the Contractor may provide 48 hours notice. Failure of the Contractor to have the aforementioned items completed prior to the mutually agreed upon start date and failure to notify the Commissioning Authority within the aforementioned notification period will result in the Contractor being liable for all travel expenses incurred by Commissioning Agent which include all miles traveled and the time allocated for the Commissioning Authority to travel to and from the project site. Travel miles will be billed at the current year standard mileage rate as defined by the Internal Revenue Service. Hours for this travel will be billed at the nominal rate of $120 per hour.

1.9 CxA'S RESPONSIBILITIES

A. Organize and lead the Commissioning Team.

B. Provide and maintain Commissioning Plan.

C. Convene commissioning team meetings.

D. Provide project-specific construction pre-functional checklists and commissioning functional performance test procedures.

E. Verify the execution of commissioning process activities using focused, quality-based sampling. The sampling rate for typical, non-major installations and remediation is as defined in the Acceptance Procedures section of this specification. Verification will include, but is not limited to, equipment submittals, pre-functional checklists, training, operating and maintenance data, tests, and test reports. When a focused, quality-based sample does not meet the requirements of

the minimum performance specifications, the CxA will report the deficiency in the Issues and Benefits Log.

F. Prepare and maintain the Issues and Benefits Log.

G. Prepare and maintain completed construction pre-functional checklist log.

H. Witness systems, assemblies, equipment, and component startup.

I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide all tools, services and instruments required to test and adjust equipment and to verify compliance.

B. Provide calibration documentation, dated less than one (1) year of the date of use, for all tools and instruments used during functional performance testing.

PART 3 - EXECUTION

3.1 COORDINATION

A. Review the Commissioning Plan.

B. Attend all commissioning coordination meetings.

C. Include commissioning activities in the Master Construction Schedule.
1. The master scheduling process will include the designation of contractor personnel required to perform the Function Performance Tests and coordination of deferred testing due to season, tenant fit-out schedule, etc.

3.2 TRAINING

A. Provide training for hardware and major components as specified within related sections and in the *Commissioning Plan*.

B. The Contractor is responsible for training coordination, scheduling and ensuring that training is completed per contract specifications.

C. The CxA shall help facilitate and oversee the training planning process for commissioned equipment and systems, however, all responsibility for providing training content and delivery is the Contractor’s per the contract documents, including this specification section.

D. No later than two (2) weeks following acceptance of equipment and system submittals, the responsible Contractor will submit written training session plans to the CxA for review and approval. There shall be one session plan for each specification section requiring training. Each session plan will consider the following elements:
   1. Equipment/systems covered in each training session
   2. Intended audience
   3. Location of training
   4. Objectives
   5. Subjects covered (description, duration of discussion, special methods, etc.)
   6. Duration of training for each subject
   7. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
   8. Instructor and qualifications
   9. Option of three dates to hold the training session

E. The responsible Contractor works with the Commissioning Authority to develop an overall training plan (i.e., multiple training "sessions") for the commissioned systems.

F. The Contractors and vendors shall provide training. The Training Sessions provided by the responsible Contractors shall be customized for this project and reflect all the installed equipment and systems. Trainings of the materials, components, systems and equipment shall, at the minimum, incorporate the following items:
   1. Materials, components, systems and equipment
   2. Safety precautions and procedures.
   3. Installation.
   4. Operational features and functions.
   5. Operational testing and diagnostics.
   6. Preventive and predictive maintenance.
   7. Service: Repair and replacement.
   8. Operation and Maintenance manual content
   9. Testing, adjusting, calibration and balancing.
   10. Contractor furnished spare parts and extra materials.
   11. Recommended "attic stock" inventory not furnished by contractor.
   12. Specialty tool requirements.
   13. Lubricants
   14. Fuels.
   15. Identification systems.
   16. Automatic/manual control systems.
   17. Hazards/Material Safety Data Sheets
   18. Cleaning
   19. Procurement of replacement parts
   20. Warranty reviews including terms and conditions, points of contact, return material procedures, effective date, extended warranty options.
   21. Maintenance agreements and similar continuing commitments.

G. Obtain written acceptance of the training session from the Owner. CxA will coordinate Owner approval of submitted training plans.

H. At a minimum, document performance of each training session with a form including the following. Submit completed forms to the CxA through the GC no later than one (1) week following acceptable completion of the training session.

1. Date of training
2. Sign-in sheet of attendees and their affiliation
3. Sign-off (acceptance) by CxA and Owner

I. Comply with requirements as specified in other specification sections.

3.3 EQUIPMENT START-UP AND EQUIPMENT ENERGIZATION

A. The Contractor will inform CxA at least 48 hours in advance of the scheduled on-site start-up or equipment energization. CxA reserves the right to witness the performance of any or all start-up/energization procedures.

B. Conduct start-up and energization with authorized personnel who are factory-trained on the equipment being started. These personnel shall document the startup procedure, adjustments made, and results achieved. Record this information according to the startup checklist requirements provided by the associated equipment/system manufacturer.

C. Provide documented start-up reports to the CxA. Reports shall be complete, legible, dated, and signed by the factory trained and authorized representatives performing the associated work for the various systems being commissioned within one week of start-up.

D. Subcontractor/Installers shall forward to the CxA through the General Contractor a list and schedule of specified startup reports.

3.4 TESTING, ADJUSTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. The TAB contractor's test and balance engineer shall conduct a final inspection in the presence of Engineer and Commissioning Authority.
   1. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
   2. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   3. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
   4. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
      a. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

D. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

E. If any portion of this specification section contradicts or duplicates requirements found elsewhere in the Contract Documents, the more stringent requirements shall apply.

3.5 ACCEPTANCE PROCEDURES

A. Prior to functional performance testing of each system, the CxA will observe and verify that the physical installation of components and systems being tested is substantially installed in accordance with the minimum performance requirements of the project specifications and the *San Antonio Housing Authority EPC Phase II Investment Grade Audit*. As deemed necessary by the Owner and CxA, the CxA shall witness verification of operation for select typical, non-major installations and remediation as during observation and verification as part of the acceptance process. The number of observations and verifications will be approximately as follows:
   1. Major Equipment Retrofits: 100%
   2. Typical, Non-Major installations and remediation: Equipment mock-ups, and the greater of 2% or 30 installations and remediation for each typical, non-major installation and remediation measure type identified in the *Project Narrative*.
      a. For each ECM, if more than 10% of the Typical, Non-Major installations or remediation are found with deficiencies, then an additional 2% or 30 installations (a.k.a. second sampling group) shall be observed and verified. If more than 10% of the second sampling group is found with deficiencies, then an additional 10% of installations or remediation (a.k.a. third sampling group) will be observed and verified. If more than 5% of the third sampling group is found with deficiencies, then each and every installation or remediation from that specific ECM shall be observed and verified.
      b. If the initial focused, quality-based sampling for each ECM is found deficient, the Contractor shall be liable for all travel expenses and time incurred to observe and identify the second, third and fourth sampling groups for that ECM. Travel miles will be billed at the current year standard mileage rate as defined by the Internal Revenue Service. Hours will be billed at the nominal rate of $120 per hour.

B. Contractor's Tests:
   1. Check system for proper installation, and adjust and calibrate to verify that system is ready to function as specified.
   2. Check system elements to verify that they have been installed properly and that all connections have been made correctly.
   3. Adjust discrete elements and sub-systems and check for proper operation.

C. The Contractor shall provide technicians and installers as required by the CxA during observation and verification. Technicians and installers shall be knowledgeable on the installation or remediation and proficient on the equipment, components and systems being observed and verified.

3.6 FUNCTIONAL PERFORMANCE TESTS

A. Objective of these tests is to demonstrate that systems are operating and complying with specified performance requirements. In general, the procedures will test the following parameters:
   1. Operate each system through all modes of system, including individual interlocks and conditional control logic, all control sequences, both full-load and part-load conditions and simulation of all abnormal conditions for which there is a specified system or controls response.
   2. Impose temporary upsets of systems, such as distribution fault, control loss, setpoint change, equilibrium upset and component failure at different operation loads to determine system stability and recovery time.

B. The Contractor shall satisfactorily execute the Functional Performance Tests prior to the CxA witnessing and verifying the test execution.

C. Functional Performance Tests will be witnessed and endorsed by the CxA upon satisfactory completion. The CxA will recommend acceptance of the systems or identify deficiencies requiring correction and re-testing.

D. The final project specific Functional Performance Test procedures will be prepared by the CxA following Contract Award.

E. The Contractor shall review and comment on the Functional Performance Tests developed by the CxA based on approved equipment submittals and Operations & Maintenance manuals. Provide feedback as to the efficiency of the procedures and possible alternate approaches to achieving the same results.

F. Provide personnel and equipment as required to perform the Functional Performance Tests during CxA verification.

G. Verification of all Functional Performance Tests for each system shall be completed prior to occupancy or partial occupancy of the building.

H. For systems where only a sample of the equipment is subjected to a Functional Performance Test, the failing Functional Performance Test will be retested and an additional sample equal in size to the previous sample will be subjected to the Functional Performance Test.

I. Corrective Measures: If acceptable performance cannot be achieved, identify the cause of the deficiency. If it is determined that the deficiency was caused by the system or component not being installed according to manufacturer's recommendations or Contract Documents, make necessary corrections. Repeat every check or test for which acceptable performance was not achieved after the necessary corrective measures have been completed. Repeat re-testing process until acceptable performance is achieved. Contractor will be allowed one retest after initial testing of the equipment. If the retest fails, subsequent retests will be performed at the Installation Contractor’s expense.

3.7 CORRECTIVE ACTIONS

A. Perform corrective actions for resolution of deficiencies found during any step of the commissioning process.

B. For functional performance testing, a deficiency is defined as equipment that does not function as expected and more than five (5) minutes is required to correct the problem in the field during the testing verification.

C. The time and expense of the CxA to witness repeat Functional Performance Testing that is a result of a deficiency of corrective action resolution shall be considered as additional cost to the Owner. The total sum of such costs shall be deducted from the final payment to the Contractor.

3.8 OCCUPANCY AND WARRANTY PHASE COMMISSIONING

A. The Contractor and CxA will complete seasonal Functional Performance Testing in accordance with the Cx Plan and the above requirements of this specification section. In general, the season functional performance testing will require reconvening the Cx Team (Construction, CxA and Owner) to test system performance during the opposite season from the original functional performance testing (e.g. heating systems testing if systems originally tested during summer).
   1. The Contractor shall anticipate a total of 2 optimization efforts in addition to the initial functional performance testing and any re-testing for each central plant retrofit. The intent is to adjust setpoints, review operation and test system modification to achieve optimized performance. The Contractor shall provide skilled technicians or manufacturer’s personnel as needed to optimize the central plant operation.

B. The Contractor and CxA will review building operation approximately 8-10 months after the Date of Substantial Completion along with the Owner's operations and maintenance staff. The review will include reviewing any open items identified on the Cx Issues/Benefits Log, trend analysis results as completed by the CxA and any known or potential warranty items.

C. The Contractor and CxA will document a plan, if required, for resolution or correction of outstanding commissioning issues. The plan will identify each issue separately, with an agreed upon resolution; deadline for implementation of corrective measures; party or parties responsible for corrective measures and any criteria required for owner acceptance of the corrective measure.

END OF SECTION 019113

ATTACHMENT A
HUD Forms and
Conflict of Interest Questionnaire
Form 1295 Certificate of Interested Parties

*(Form 1295 is to be completed online by the ***Selected Respondent*** and submitted to the Texas Ethics Commission pursuant to Government Code 2252.908 and a copy returned to SAHA with the Certification prior to contract execution. A copy of the 1295 Form is included herein for information purposes only).*

Instructions to Offerors Non-Construction

U.S. Department of Housing and Urban Development
Office of Public and Indian Housing

- 03291 -

1. Preparation of Offers

(a) Offerors are expected to examine the statement of work, the proposed contract terms and conditions, and all instructions. Failure to do so will be at the offeror's risk.

(b) Each offeror shall furnish the information required by the solicitation. The offeror shall sign the offer and print or type its name on the cover sheet and each continuation sheet on which it makes an entry. Erasures or other changes must be initialed by the person signing the offer. Offers signed by an agent shall be accompanied by evidence of that agent's authority, unless that evidence has been previously furnished to the HA.

(c) Offers for services other than those specified will not be considered.

2. Submission of Offers

(a) Offers and modifications thereof shall be submitted in sealed envelopes or packages (1) addressed to the office specified in the solicitation, and (2) showing the time specified for receipt, the solicitation number, and the name and address of the offeror.

(b) Telegraphic offers will not be considered unless authorized by the solicitation; however, offers may be modified by written or telegraphic notice.

(c) Facsimile offers, modifications or withdrawals will not be considered unless authorized by the solicitation.

3. Amendments to Solicitations

(a) If this solicitation is amended, then all terms and conditions which are not modified remain unchanged.

(b) Offerors shall acknowledge receipt of any amendments to this solicitation by

(1) signing and returning the amendment;
(2) identifying the amendment number and date in the space provided for this purpose on the form for submitting an offer,
(3) letter or telegram, or
(4) facsimile, if facsimile offers are authorized in the solicitation. The HA/HUD must receive the acknowledgment by the time specified for receipt of offers.

4. Explanation to Prospective Offerors

Any prospective offeror desiring an explanation or interpretation of the solicitation, statement of work, etc., must request it in writing soon enough to allow a reply to reach all prospective offerors before the submission of their offers. Oral explanations or instructions given before the award of the contract will not be binding. Any information given to a prospective offeror concerning a solicitation will be furnished promptly to all other prospective offerors as an amendment of the solicitation, if that information is necessary in submitting offers or if the lack of it would be prejudicial to any other prospective offerors.

5. Responsibility of Prospective Contractor

(a) The HA shall award a contract only to a responsible prospective contractor who is able to perform successfully under the terms and conditions of the proposed contract. To be determined responsible, a prospective contractor must -

(1) Have adequate financial resources to perform the contract, or the ability to obtain them;
(2) Have a satisfactory performance record;
(3) Have a satisfactory record of integrity and business ethics;
(4) Have a satisfactory record of compliance with public policy (e.g., Equal Employment Opportunity); and
(5) Not have been suspended, debarred, or otherwise determined to be ineligible for award of contracts by the Department of Housing and Urban Development or any other agency of the U.S. Government. Current lists of ineligible contractors are available for inspection at the HA/HUD.

(b) Before an offer is considered for award, the offeror may be requested by the HA to submit a statement or other documentation regarding any of the foregoing requirements. Failure by the offeror to provide such additional information may render the offeror ineligible for award.

6. Late Submissions, Modifications, and Withdrawal of Offers

(a) Any offer received at the place designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before award is made and it -

(1) Was sent by registered or certified mail not later than the fifth calendar day before the date specified for receipt of offers (e.g., an offer submitted in response to a solicitation requiring receipt of offers by the 20th of the month must have been mailed by the 15th);
(2) Was sent by mail, or if authorized by the solicitation, was sent by telegram or via facsimile, and it is determined by the HA/HUD that the late receipt was due solely to mishandling by the HA/HUD after receipt at the HA;
(3) Was sent by U.S. Postal Service Express Mail Next Day Service - Post Office to Addressee, not later than 5:00 p.m. at the place of mailing two working days prior to the date specified for receipt of proposals. The term "working days" excludes weekends and U.S. Federal holidays; or
(4) Is the only offer received.

(b) Any modification of an offer, except a modification resulting from the HA's request for "best and final" offer (if this solicitation is a request for proposals), is subject to the same conditions as in subparagraphs (a)(1), (2), and (3) of this provision.

(c) A modification resulting from the HA's request for "best and final" offer received after the time and date specified in the request will not be considered unless received before award and the late receipt is due solely to mishandling by the HA after receipt at the HA.

(d) The only acceptable evidence to establish the date of mailing of a late offer, modification, or withdrawal sent either by registered or certified mail is the U.S. or Canadian Postal Service postmark both on the envelope or wrapper and on the original receipt from the U.S. or Canadian Postal Service. Both postmarks must show a legible date or the offer, modification, or withdrawal shall be processed as if mailed late. "Postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed by employees of the U.S. or Canadian Postal Service on the date of mailing. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper.

(e) The only acceptable evidence to establish the time of receipt at the HA is the time/date stamp of HA on the offer wrapper or other documentary evidence of receipt maintained by the HA.

(f) The only acceptable evidence to establish the date of mailing of a late offer, modification, or withdrawal sent by Express Mail Next Day Service-Post Office to Addressee is the date entered by the post office receiving clerk on the "Express Mail Next Day Service-Post Office to Addressee" label and the postmark on both the envelope or wrapper and on the original receipt from the U.S. Postal Service. "Postmark" has the same meaning as defined in paragraph (c) of this provision, excluding postmarks of the Canadian Postal Service. Therefore, offerors should request the postal clerk to place a legible hand cancellation bull's eye postmark on both the receipt and the envelope or wrapper.

(g) Notwithstanding paragraph (a) of this provision, a late modification of an otherwise successful offer that makes its terms more favorable to the HA will be considered at any time it is received and may be accepted.

(h) If this solicitation is a request for proposals, proposals may be withdrawn by written notice, or if authorized by this solicitation, by telegram (including mailgram) or facsimile machine transmission received at any time before award. Proposals may be withdrawn in person by a offeror or its authorized representative if the identity of the person requesting withdrawal is established and the person signs a receipt for the offer before award. If this solicitation is an invitation for bids, bids may be withdrawn at any time prior to bid opening.

7. Contract Award

(a) The HA will award a contract resulting from this solicitation to the responsible offeror whose offer conforming to the solicitation will be most advantageous to the HA, cost or price and other factors, specified elsewhere in this solicitation, considered.

(b) The HA may
(1) reject any or all offers if such action is in the HA's interest,
(2) accept other than the lowest offer,
(3) waive informalities and minor irregularities in offers received, and (4) award more than one contract for all or part of the requirements stated.

(c) If this solicitation is a request for proposals, the HA may award a contract on the basis of initial offers received, without discussions. Therefore, each initial offer should contain the offeror's best terms from a cost or price and technical standpoint.

(d) A written award or acceptance of offer mailed or otherwise furnished to the successful offeror within the time for acceptance specified in the offer shall result in a binding contract without further action by either party. If this solicitation is a request for proposals, before the offer's specified expiration time, the HA may accept an offer, whether or not there are negotiations after its receipt, unless a written notice of withdrawal is received before award. Negotiations conducted after receipt of an offer do not constitute a rejection or counteroffer by the HA.

(e) Neither financial data submitted with an offer, nor representations concerning facilities or financing, will form a part of the resulting contract.

8. Service of Protest

Any protest against the award of a contract pursuant to this solicitation shall be served on the HA by obtaining written and dated acknowledgment of receipt from the HA at the address shown on the cover of this solicitation. The determination of the HA with regard to such protest or to proceed to award notwithstanding such protest shall be final unless appealed by the protestor.

9. Offer Submission

Offers shall be submitted as follows and shall be enclosed in a sealed envelope and addressed to the office specified in the solicitation. The proposal shall show **the hour and date specified in the solicitation for receipt, the solicitation number, and the name and address of the offeror, on the face of the envelope.**

It is very important that the offer be properly identified on the face of the envelope as set forth above in order to insure that the date and time of receipt is stamped on the face of the offer envelope. Receiving procedures are: date and time stamp those envelopes identified as proposals and deliver them immediately to the appropriate contracting official, and only date stamp those envelopes which do not contain identification of the contents and deliver them to the appropriate procuring activity only through the routine mail delivery procedure.

[Describe bid or proposal preparation instructions here:]

General Conditions for Non-Construction Contracts

Section I – (With or without Maintenance Work)

U.S. Department of Housing and Urban Development
Office of Public and Indian Housing
Office of Labor Relations
OMB Approval No. 2577-0157 (exp. 1/31/2017)

Applicability. This form HUD-5370-C has 2 Sections. These Sections must be inserted into non-construction contracts as described below:

1) **Non-construction contracts** (*without* maintenance) **greater than $100,000 - use Section I**;
2) **Maintenance contracts** (including nonroutine maintenance as defined at 24 CFR 968.105) **greater than $2,000 but not more than $100,000 - use Section II**; and
3) **Maintenance contracts** (including nonroutine maintenance), **greater than $100,000 – use Sections I and II**.

Section I - Clauses for All Non-Construction Contracts greater than $100,000

1. Definitions

The following definitions are applicable to this contract:

(a) "Authority or Housing Authority (HA)" means the Housing Authority.
(b) "Contract" means the contract entered into between the Authority and the Contractor. It includes the contract form, the Certifications and Representations, these contract clauses, and the scope of work. It includes all formal changes to any of those documents by addendum, Change Order, or other modification.
(c) "Contractor" means the person or other entity entering into the contract with the Authority to perform all of the work required under the contract.
(d) "Day" means calendar days, unless otherwise stated.
(e) "HUD" means the Secretary of Housing and Urban development, his delegates, successors, and assigns, and the officers and employees of the United States Department of Housing and Urban Development acting for and on behalf of the Secretary.

2. Changes

(a) The HA may at any time, by written order, and without notice to the sureties, if any, make changes within the general scope of this contract in the services to be performed or supplies to be delivered.
(b) If any such change causes an increase or decrease in the hourly rate, the not-to-exceed amount of the contract, or the time required for performance of any part of the work under this contract, whether or not changed by the order, or otherwise affects the conditions of this contract, the HA shall make an equitable adjustment in the not-to-exceed amount, the hourly rate, the delivery schedule, or other affected terms, and shall modify the contract accordingly.
(c) The Contractor must assert its right to an equitable adjustment under this clause within 30 days from the date of receipt of the written order. However, if the HA decides that the facts justify it, the HA may receive and act upon a proposal submitted before final payment of the contract.
(d) Failure to agree to any adjustment shall be a dispute under clause Disputes, herein. However, nothing in this clause shall excuse the Contractor from proceeding with the contract as changed.
(e) No services for which an additional cost or fee will be charged by the Contractor shall be furnished without the prior written consent of the HA.

3. Termination for Convenience and Default

(a) The HA may terminate this contract in whole, or from time to time in part, for the HA's convenience or the failure of the Contractor to fulfill the contract obligations (default). The HA shall terminate by delivering to the Contractor a written Notice of Termination specifying the nature, extent, and effective date of the termination. Upon receipt of the notice, the Contractor shall: (i) immediately discontinue all services affected (unless the notice directs otherwise); and (ii) deliver to the HA all information, reports, papers, and other materials accumulated or generated in performing this contract, whether completed or in process.
(b) If the termination is for the convenience of the HA, the HA shall be liable only for payment for services rendered before the effective date of the termination.
(c) If the termination is due to the failure of the Contractor to fulfill its obligations under the contract (default), the HA may (i) require the Contractor to deliver to it, in the manner and to the extent directed by the HA, any work as described in subparagraph (a)(ii) above, and compensation be determined in accordance with the Changes clause, paragraph 2, above; (ii) take over the work and prosecute the same to completion by contract or otherwise, and the Contractor shall be liable for any additional cost incurred by the HA; (iii) withhold any payments to the Contractor, for the purpose of off-set or partial payment, as the case may be, of amounts owed to the HA by the Contractor.
(d) If, after termination for failure to fulfill contract obligations (default), it is determined that the Contractor had not failed, the termination shall be deemed to have been effected for the convenience of the HA, and the Contractor shall been titled to payment as described in paragraph (b) above.
(e) Any disputes with regard to this clause are expressly made subject to the terms of clause titled Disputes herein.

4. Examination and Retention of Contractor's Records

(a) The HA, HUD, or Comptroller General of the United States, or any of their duly authorized representatives shall, until 3 years after final payment under this contract, have access to and the right to examine any of the Contractor's directly pertinent books, documents, papers, or other records involving transactions related to this contract for the purpose of making audit, examination, excerpts, and transcriptions.

(b) The Contractor agrees to include in first-tier subcontracts under this contract a clause substantially the same as paragraph (a) above. "Subcontract," as used in this clause, excludes purchase orders not exceeding $10,000.
(c) The periods of access and examination in paragraphs (a) and (b) above for records relating to:
(i) appeals under the clause titled Disputes;
(ii) litigation or settlement of claims arising from the performance of this contract; or,
(iii) costs and expenses of this contract to which the HA, HUD, or Comptroller General or any of their duly authorized representatives has taken exception shall continue until disposition of such appeals, litigation, claims, or exceptions.

5. Rights in Data (Ownership and Proprietary Interest)

The HA shall have exclusive ownership of, all proprietary interest in, and the right to full and exclusive possession of all information, materials and documents discovered or produced by Contractor pursuant to the terms of this Contract, including but not limited to reports, memoranda or letters concerning the research and reporting tasks of this Contract.

6. Energy Efficiency

The contractor shall comply with all mandatory standards and policies relating to energy efficiency which are contained in the energy conservation plan issued in compliance with the Energy Policy and Conservation Act (Pub.L. 94-163) for the State in which the work under this contract is performed.

7. Disputes

(a) All disputes arising under or relating to this contract, *except for disputes arising under clauses contained in Section III, Labor Standards Provisions*, including any claims for damages for the alleged breach there of which are not disposed of by agreement, shall be resolved under this clause.
(b) All claims by the Contractor shall be made in writing and submitted to the HA. A claim by the HA against the Contractor shall be subject to a written decision by the HA.
(c) The HA shall, with reasonable promptness, but in no event in no more than 60 days, render a decision concerning any claim hereunder. Unless the Contractor, within 30 days after receipt of the HA's decision, shall notify the HA in writing that it takes exception to such decision, the decision shall be final and conclusive.
(d) Provided the Contractor has (i) given the notice within the time stated in paragraph (c) above, and (ii) excepted its claim relating to such decision from the final release, and (iii) brought suit against the HA not later than one year after receipt of final payment, or if final payment has not been made, not later than one year after the Contractor has had a reasonable time to respond to a written request by the HA that it submit a final voucher and release, whichever is earlier, then the HA's decision shall not be final or conclusive, but the dispute shall be determined on the merits by a court of competent jurisdiction.
(e) The Contractor shall proceed diligently with performance of this contract, pending final resolution of any request for relief, claim, appeal, or action arising under the contract, and comply with any decision of the HA.

8. Contract Termination; Debarment

A breach of these Contract clauses may be grounds for termination of the Contract and for debarment or denial of participation in HUD programs as a Contractor and a subcontractor as provided in 24 CFR Part 24.

9. Assignment of Contract

The Contractor shall not assign or transfer any interest in this contract; except that claims for monies due or to become due from the HA under the contract may be assigned to a bank, trust company, or other financial institution. If the Contractor is a partnership, this contract shall inure to the benefit of the surviving or remaining member(s) of such partnership approved by the HA.

10. Certificate and Release

Prior to final payment under this contract, or prior to settlement upon termination of this contract, and as a condition precedent thereto, the Contractor shall execute and deliver to the HA a certificate and release, in a form acceptable to the HA, of all claims against the HA by the Contractor under and by virtue of this contract, other than such claims, if any, as may be specifically excepted by the Contractor in stated amounts set forth therein.

11. Organizational Conflicts of Interest

(a) The Contractor warrants that to the best of its knowledge and belief and except as otherwise disclosed, it does not have any organizational conflict of interest which is defined as a situation in which the nature of work under this contract and a contractor's organizational, financial, contractual or other interests are such that:
(i) Award of the contract may result in an unfair competitive advantage; or
(ii) The Contractor's objectivity in performing the contract work may be impaired.
(b) The Contractor agrees that if after award it discovers an organizational conflict of interest with respect to this contract or any task/delivery order under the contract, he or she shall make an immediate and full disclosure in writing to the Contracting Officer which shall include a description of the action which the Contractor has taken or intends to take to eliminate or neutralize the conflict. The HA may, however, terminate the contract or task/delivery order for the convenience of the HA if it would be in the best interest of the HA.
(c) In the event the Contractor was aware of an organizational conflict of interest before the award of this contract and intentionally did not disclose the conflict to the Contracting Officer, the HA may terminate the contract for default.
(d) The terms of this clause shall be included in all subcontracts and consulting agreements wherein the work to be performed is similar to the service provided by the prime Contractor. The Contractor shall include in such subcontracts and consulting agreements any necessary provisions to eliminate or neutralize conflicts of interest.

12. Inspection and Acceptance

(a) The HA has the right to review, require correction, if necessary, and accept the work products produced by the Contractor. Such review(s) shall be carried out within 30 days so as to not impede the work of the Contractor. Any

product of work shall be deemed accepted as submitted if the HA does not issue written comments and/or required corrections within 30 days from the date of receipt of such product from the Contractor.

(b) The Contractor shall make any required corrections promptly at no additional charge and return a revised copy of the product to the HA within 7 days of notification or a later date if extended by the HA.

(c) Failure by the Contractor to proceed with reasonable promptness to make necessary corrections shall be a default. If the Contractor's submission of corrected work remains unacceptable, the HA may terminate this contract (or the task order involved) or reduce the contract price or cost to reflect the reduced value of services received.

13. Interest of Members of Congress

No member of or delegate to the Congress of the United States of America or Resident Commissioner shall be admitted to any share or part of this contract or to any benefit to arise there from, but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

14. Interest of Members, Officers, or Employees and Former Members, Officers, or Employees

No member, officer, or employee of the HA, no member of the governing body of the locality in which the project is situated, no member of the governing body in which the HA was activated, and no other pubic official of such locality or localities who exercises any functions or responsibilities with respect to the project, shall, during his or her tenure, or for one year thereafter, have any interest, direct or indirect, in this contract or the proceeds thereof.

15. Limitation on Payments to Influence Certain Federal Transactions

(a) Definitions. As used in this clause:

"Agency", as defined in 5 U.S.C. 552(f), includes Federal executive departments and agencies as well as independent regulatory commissions and Government corporations, as defined in 31 U.S.C. 9101(1).

"Covered Federal Action" means any of the following Federal actions:

(i) The awarding of any Federal contract;

(ii) The making of any Federal grant;

(iii) The making of any Federal loan;

(iv) The entering into of any cooperative agreement; and,

(v) The extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

Covered Federal action does not include receiving from an agency a commitment providing for the United States to insure or guarantee a loan.

"Indian tribe" and "tribal organization" have the meaning provided in section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450B). Alaskan Natives are included under the definitions of Indian tribes in that Act.

"Influencing or attempting to influence" means making, with the intent to influence, any communication to or appearance before an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with any covered Federal action.

"Local government" means a unit of government in a State and, if chartered, established, or otherwise recognized by a State for the performance of a governmental duty, including a local public authority, a special district, an intrastate district, a council of governments, a sponsor group representative organization, and any other instrumentality of a local government.

"Officer or employee of an agency" includes the following individuals who are employed by an agency:

(i) An individual who is appointed to a position in the Government under title 5, U.S.C., including a position under a temporary appointment;

(ii) A member of the uniformed services as defined in section 202, title 18, U.S.C.;

(iii) A special Government employee as defined in section 202, title 18, U.S.C.; and,

(iv) An individual who is a member of a Federal advisory committee, as defined by the Federal Advisory Committee Act, title 5, appendix 2.

"Person" means an individual, corporation, company, association, authority, firm, partnership, society, State, and local government, regardless of whether such entity is operated for profit or not for profit. This term excludes an Indian tribe, tribal organization, or other Indian organization with respect to expenditures specifically permitted by other Federal law.

"Recipient" includes all contractors, subcontractors at any tier, and subgrantees at any tier of the recipient of funds received in connection with a Federal contract, grant, loan, or cooperative agreement. The term excludes an Indian tribe, tribal organization, or any other Indian organization with respect to expenditures specifically permitted by other Federal law.

"Regularly employed means, with respect to an officer or employee of a person requesting or receiving a Federal contract, grant, loan, or cooperative agreement, an officer or employee who is employed by such person for at least 130 working days within one year immediately preceding the date of the submission that initiates agency consideration of such person for receipt of such contract, grant, loan, or cooperative agreement. An officer or employee who is employed by such person for less than 130 working days within one year immediately preceding the date of submission that initiates agency consideration of such person shall be considered to be regularly employed as soon as he or she is employed by such person for 130 working days.

"State" means a State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, a territory or possession of the United States, an agency or instrumentality of a State, and a multi-State, regional, or interstate entity having governmental duties and powers.

(b) Prohibition.

(i) Section 1352 of title 31, U.S.C. provides in part that no appropriated funds may be expended by the recipient of a Federal contract, grant, loan, or cooperative agreement to pay any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with any of the following covered Federal actions: the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(ii) The prohibition does not apply as follows:

(1) Agency and legislative liaison by Own Employees.

(a) The prohibition on the use of appropriated funds, in paragraph (i) of this section, does not apply in the case of a payment of reasonable compensation made to an officer or employee of a person requesting or receiving a Federal contract, grant, loan, or cooperative agreement, if the payment is for agency and legislative activities not directly related to a covered Federal action.

(b) For purposes of paragraph (b)(i)(1)(a) of this clause, providing any information specifically requested by an agency or Congress is permitted at any time.

(c) The following agency and legislative liaison activities are permitted at any time only where they are not related to a specific solicitation for any covered Federal action:

(1) Discussing with an agency (including individual demonstrations) the qualities and characteristics of the person's products or services, conditions or terms of sale, and service capabilities; and,

(2) Technical discussions and other activities regarding the application or adaptation of the person's products or services for an agency's use.

(d) The following agency and legislative liaison activities are permitted where they are prior to formal solicitation of any covered Federal action:

(1) Providing any information not specifically requested but necessary for an agency to make an informed decision about initiation of a covered Federal action;

(2) Technical discussions regarding the preparation of an unsolicited proposal prior to its official submission; and

(3) Capability presentations by persons seeking awards from an agency pursuant to the provisions of the Small Business Act, as amended by Public Law 95-507 and other subsequent amendments.

(e) Only those activities expressly authorized by subdivision (b)(ii)(1)(a) of this clause are permitted under this clause.

(2) Professional and technical services.

(a) The prohibition on the use of appropriated funds, in subparagraph (b)(i) of this clause, does not apply in the case of-

(i) A payment of reasonable compensation made to an officer or employee of a person requesting or receiving a covered Federal action or an extension, continuation, renewal, amendment, or modification of a covered Federal action, if payment is for professional or technical services rendered directly in the preparation, submission, or negotiation of any bid, proposal, or application for that Federal action or for meeting requirements imposed by or pursuant to law as a condition for receiving that Federal action.

(ii) Any reasonable payment to a person, other than an officer or employee of a person requesting or receiving a covered Federal action or an extension, continuation, renewal, amendment, or modification of a covered Federal action if the payment is for professional or technical services rendered directly in the preparation, submission, or negotiation of any bid, proposal, or application for that Federal action or for meeting requirements imposed by or pursuant to law as a condition for receiving that Federal action. Persons other than officers or employees of a person requesting or receiving a covered Federal action include consultants and trade associations.

(b) For purposes of subdivision (b)(ii)(2)(a) of clause, "professional and technical services" shall be limited to advice and analysis directly applying any professional or technical discipline.

(c) Requirements imposed by or pursuant to law as a condition for receiving a covered Federal award include those required by law or regulation, or reasonably expected to be required by law or regulation, and any other requirements in the actual award documents.

(d) Only those services expressly authorized by subdivisions (b)(ii)(2)(a)(i) and (ii) of this section are permitted under this clause.

(iii) Selling activities by independent sales representatives.

(c) The prohibition on the use of appropriated funds, in subparagraph (b)(i) of this clause, does not apply to the following selling activities before an agency by independent sales representatives, provided such activities are prior to formal solicitation by an agency and are specifically limited to the merits of the matter:

(i) Discussing with an agency (including individual demonstration) the qualities and characteristics of the person's products or services, conditions or terms of sale, and service capabilities; and

(ii) Technical discussions and other activities regarding the application or adaptation of the person's products or services for an agency's use.

(d) Agreement. In accepting any contract, grant, cooperative agreement, or loan resulting from this solicitation, the person submitting the offer agrees not to make any payment prohibited by this clause.

(e) Penalties. Any person who makes an expenditure prohibited under paragraph (b) of this clause shall be subject to civil penalties as provided for by 31 U.S.C. 1352. An imposition of a civil penalty does not prevent the Government from seeking any other remedy that may be applicable.

(f) Cost Allowability. Nothing in this clause is to be interpreted to make allowable or reasonable any costs which would be unallowable or unreasonable in accordance with Part 31 of the Federal Acquisition Regulation (FAR), or OMB Circulars dealing with cost allowability for recipients of assistance agreements. Conversely, costs made specifically unallowable by the requirements in this clause will not be made allowable under any of the provisions of FAR Part 31 or the relevant OMB Circulars.

16. Equal Employment Opportunity

During the performance of this contract, the Contractor agrees as follows:

(a) The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

(b) The Contractor shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to (1) employment; (2) upgrading; (3) demotion; (4) transfer; (5) recruitment or recruitment advertising; (6) layoff or termination; (7) rates of pay or other forms of compensation; and (8) selection for training, including apprenticeship.

(c) The Contractor shall post in conspicuous places available to employees and applicants for employment the notices to be provided by the Contracting Officer that explain this clause.

(d) The Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(e) The Contractor shall send, to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, the notice to be provided by the Contracting Officer advising the labor union or workers' representative of the Contractor's commitments under this clause, and post copies of the notice in conspicuous places available to employees and applicants for employment.

(f) The Contractor shall comply with Executive Order 11246, as amended, and the rules, regulations, and orders of the Secretary of Labor.

(g) The Contractor shall furnish all information and reports required by Executive Order 11246, as amended and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto. The Contractor shall permit access to its books, records, and accounts by the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(h) In the event of a determination that the Contractor is not in compliance with this clause or any rule, regulation, or order of the Secretary of Labor, this contract may be canceled, terminated, or suspended in whole or in part, and the Contractor may be declared ineligible for further Government contracts, or federally assisted construction contracts under the procedures authorized in Executive Order 11246, as amended. In addition, sanctions may be imposed and remedies invoked against the Contractor as provided in Executive Order 11246, as amended, the rules, regulations, and orders of the Secretary of Labor, or as otherwise provided by law.

(i) The Contractor shall include the terms and conditions of this clause in every subcontract or purchase order unless exempted by the rules, regulations, or orders of the Secretary of Labor issued under Executive Order 11246, as amended, so that these terms and conditions will be binding upon each subcontractor or vendor. The Contractor shall take such action with respect to any subcontractor or purchase order as the Secretary of Housing and Urban Development or the Secretary of Labor may direct as a means of enforcing such provisions, including sanctions for noncompliance; provided that if the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction, the Contractor may request the United States to enter into the litigation to protect the interests of the United States.

17. Dissemination or Disclosure of Information

No information or material shall be disseminated or disclosed to the general public, the news media, or any person or organization without prior express written approval by the HA.

18. Contractor's Status

It is understood that the Contractor is an independent contractor and is not to be considered an employee of the HA, or assume any right, privilege or duties of an employee, and shall save harmless the HA and its employees from claims suits, actions and costs of every description resulting from the Contractor's activities on behalf of the HA in connection with this Agreement.

19. Other Contractors

HA may undertake or award other contracts for additional work at or near the site(s) of the work under this contract. The contractor shall fully cooperate with the other contractors and with HA and HUD employees and shall carefully adapt scheduling and performing the work under this contract to accommodate the additional work, heeding any direction that may be provided by the Contracting Officer. The contractor shall not commit or permit any act that will interfere with the performance of work by any other contractor or HA employee.

20. Liens

The Contractor is prohibited from placing a lien on HA's property. This prohibition shall apply to all subcontractors.

21. Training and Employment Opportunities for Residents in the Project Area (Section 3, HUD Act of 1968; 24 CFR 135)

(a) The work to be performed under this contract is subject to the requirements of section 3 of the Housing and Urban Development Act of 1968, as amended, 12 U.S.C. 1701u (section 3). The purpose of section 3 is to ensure that employment and other economic opportunities generated by HUD assistance or HUD-assisted projects covered by section 3, shall, to the greatest extent feasible, be directed to low- and very low-income persons, particularly persons who are recipients of HUD assistance for housing.

(b) The parties to this contract agree to comply with HUD's regulations in 24 CFR Part 135, which implement section 3. As evidenced by their execution of this contract, the parties to this contract certify that they are under no contractual or other impediment that would prevent them from complying with the Part 135 regulations.

(c) The contractor agrees to send to each labor organization or representative of workers with which the contractor has a collective bargaining agreement or other understanding, if any, a notice advising the labor organization or workers' representative of the contractor's commitments under this section 3 clause, and will post copies of the notice in conspicuous places at the work site where both employees and applicants for training and employment positions can see the notice. The notice shall describe the section 3 preference, shall set forth minimum number and job titles subject to hire, availability of

apprenticeship and training positions, the qualifications for each; and the name and location of the person(s) taking applications for each of the positions; and the anticipated date the work shall begin.

(d) The contractor agrees to include this section 3 clause in every subcontract subject to compliance with regulations in 24 CFR Part 135, and agrees to take appropriate action, as provided in an applicable provision of the subcontract or in this section 3 clause, upon a finding that the subcontractor is in violation of the regulations in 24 CFR Part 135. The contractor will not subcontract with any subcontractor where the contractor has notice or knowledge that the subcontractor has been found in violation of the regulations in 24 CFR Part 135.

(e) The contractor will certify that any vacant employment positions, including training positions, that are filled (1) after the contractor is selected but before the contract is executed, and (2) with persons other than those to whom the regulations of 24 CFR Part 135 require employment opportunities to be directed, were not filled to circumvent the contractor's obligations under 24 CFR Part 135.

(f) Noncompliance with HUD's regulations in 24 CFR Part 135 may result in sanctions, termination of this contract for default, and debarment or suspension from future HUD assisted contracts.

22. Procurement of Recovered Materials

(a) In accordance with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, the Contractor shall procure items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR Part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition. The Contractor shall procure items designated in the EPA guidelines that contain the highest percentage of recovered materials practicable unless the Contractor determines that such items: (1) are not reasonably available in a reasonable period of time; (2) fail to meet reasonable performance standards, which shall be determined on the basis of the guidelines of the National Institute of Standards and Technology, if applicable to the item; or (3) are only available at an unreasonable price.

(b) Paragraph (a) of this clause shall apply to items purchased under this contract where: (1) the Contractor purchases in excess of $10,000 of the item under this contract; or (2) during the preceding Federal fiscal year, the Contractor: (i) purchased any amount of the items for use under a contract that was funded with Federal appropriations and was with a Federal agency or a State agency or agency of a political subdivision of a State; and (ii) purchased a total of in excess of $10,000 of the item both under and outside that contract.

General Conditions for Non-Construction Contracts

Section II – (With Maintenance Work)

U.S. Department of Housing and Urban Development
Office of Public and Indian Housing
Office of Labor Relations
OMB Approval No. 2577-0157 (exp. 1/31/2017)

Applicability. This form HUD-5370C has 2 Sections. These Sections must be inserted into non-construction contracts as described below:

1) Non-construction contracts (*without* maintenance) greater than $100,000 - use Section I;
2) Maintenance contracts (including nonroutine maintenance as defined at 24 CFR 968.105) greater than $2,000 but not more than $100,000 - use Section II; and
3) Maintenance contracts (including nonroutine maintenance), greater than $100,000 – use Sections I and II.

Section II – Labor Standard Provisions for all Maintenance Contracts greater than $2,000

1. Minimum Wages

(a) All maintenance laborers and mechanics employed under this Contract in the operation of the project(s) shall be paid unconditionally and not less often than semi-monthly, and without subsequent deduction (except as otherwise provided by law or regulations), the full amount of wages due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Housing and Urban Development which is attached hereto and made a part hereof. Such laborers and mechanics shall be paid the appropriate wage rate on the wage determination for the classification of work actually performed, without regard to skill. Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein; provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination, including any additional classifications and wage rates approved by HUD under subparagraph 1(b), shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(b) (i) Any class of laborers or mechanics which is not listed in the wage determination and which is to be employed under the Contract shall be classified in conformance with the wage determination. HUD shall approve an additional classification and wage rate only when the following criteria have been met:

(1) The work to be performed by the classification required is not performed by a classification in the wage determination;

(2) The classification is utilized in the area by the industry; and

(3) The proposed wage rate bears a reasonable relationship to the wage rates contained in the wage determination.

(ii) The wage rate determined pursuant to this paragraph shall be paid to all workers performing work in the classification under this Contract from the first day on which work is performed in the classification.

2. Withholding of funds

The Contracting Officer, upon his/her own action or upon request of HUD, shall withhold or cause to be withheld from the Contractor under this Contract or any other contract subject to HUD-determined wage rates, with the same prime Contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics employed by the Contractor or any subcontractor the full amount of wages required by this clause. In the event of failure to pay any laborer or mechanic employed under this Contract all or part of the wages required under this Contract, the Contracting Officer or HUD may, after written notice to the Contractor, take such action as may be necessary to cause the suspension of any further payment or advance until such violations have ceased. The Public Housing Agency or HUD may, after written notice to the Contractor, disburse such amounts withheld for and on account of the Contractor or subcontractor to the respective employees to whom they are due.

3. Records

(a) The Contractor and each subcontractor shall make and maintain for three (3) years from the completion of the work records containing the following for each laborer and mechanic:

(i) Name, address and Social Security Number;
(ii) Correct work classification or classifications;
(iii) Hourly rate or rates of monetary wages paid;
(iv) Rate or rates of any fringe benefits provided;
(v) Number of daily and weekly hours worked;
(vi) Gross wages earned;
(vii) Any deductions made; and
(viii) Actual wages paid.

(b) The Contractor and each subcontractor shall make the records required under paragraph 3(a) available for inspection, copying, or transcription by authorized representatives of HUD or the HA and shall permit such representatives to interview employees during working hours on the job. If the Contractor or any subcontractor fails to make the required records available, HUD or its designee may, after written notice to the Contractor, take such action as may be necessary to cause the suspension of any further payment, advance or guarantee of funds.

4. Apprentices and Trainees

(a) Apprentices and trainees will be permitted to work at less than the predetermined rate for the work they perform when they are employed pursuant to and individually registered in:

(i) A bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration (ETA), Office of

Apprenticeship Training, Employer and Labor Services (OATELS), or with a state apprenticeship agency recognized by OATELS, or if a person is employed in his/her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by OATELS or a state apprenticeship agency (where appropriate) to be eligible for probationary employment as an apprentice; A

(ii) trainee program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, ETA; or

(iii) A training/trainee program that has received prior approval by HUD.

(b) Each apprentice or trainee must be paid at not less than the rate specified in the registered or approved program for the apprentice's/trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Apprentices and trainees shall be paid fringe benefits in accordance with the provisions of the registered or approved program. If the program does not specify fringe benefits, apprentices/trainees must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification.

(c) The allowable ratio of apprentices or trainees to journeyman on the job site in any craft classification shall not be greater than the ratio permitted to the employer as to the entire work force under the approved program.

(d) Any worker employed at an apprentice or trainee wage rate who is not registered in an approved program, and any apprentice or trainee performing work on the job site in excess of the ratio permitted under the approved program, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed.

(e) In the event OATELS, a state apprenticeship agency recognized by OATELS or ETA, or HUD, withdraws approval of an apprenticeship or trainee program, the employer will no longer be permitted to utilize apprentices/trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

5. Disputes concerning labor standards

(a) Disputes arising out of the labor standards provisions contained in Section II of this form HUD-5370-C, other than those in Paragraph 6, shall be subject to the following procedures. Disputes within the meaning of this paragraph include disputes between the Contractor (or any of its subcontractors) and the HA, or HUD, or the employees or their representatives, concerning payment of prevailing wage rates or proper classification. The procedures in this section may be initiated upon HUD's own motion, upon referral of the HA, or upon request of the Contractor or subcontractor(s).

(i) A Contractor and/or subcontractor or other interested party desiring reconsideration of findings of violation by the HA or HUD relating to the payment of straight-time prevailing wages or classification of work shall request such reconsideration by letter postmarked within 30 calendar days of the date of notice of findings issued by the HA or HUD. The request shall set forth those findings that are in dispute and the reasons, including any affirmative defenses, with respect to the violations. The request shall be directed to the appropriate HA or HUD official in accordance with instructions contained in the notice of findings or, if the notice does not specify to whom a request should be made, to the Regional Labor Relations Officer (HUD). The HA

(ii) or HUD official shall, within 60 days (unless otherwise indicated in the notice of findings) after receipt of a timely request for reconsideration, issue a written decision on the findings of violation. The written decision on reconsideration shall contain instructions that any appeal of the decision shall be addressed to the Regional Labor Relations Officer by letter postmarked within 30 calendar days after the date of the decision. In the event that the Regional Labor Relations Officer was the deciding official on reconsideration, the appeal shall be directed to the Director, Office of Labor Relations (HUD). Any appeal must set forth the aspects of the decision that are in dispute and the reasons, including any affirmative defenses, with respect to the violations. The Regional Labor

(iii) Relations Officer shall, within 60 days (unless otherwise indicated in the decision on reconsideration) after receipt of a timely appeal, issue a written decision on the findings. A decision of the Regional Labor Relations Officer may be appealed to the Director, Office of Labor Relations, by letter postmarked within 30 days of the Regional Labor Relations Officer's decision. Any appeal to the Director must set forth the aspects of the prior decision(s) that are in dispute and the reasons. The decision of the Director, Office of Labor Relations, shall be final.

(b) Disputes arising out of the labor standards provisions of paragraph 6 shall not be subject to paragraph 5(a) of this form HUD-5370C. Such disputes shall be resolved in accordance with the procedures of the U.S. Department of Labor set forth in 29 CFR Parts 5, 6 and 7. Disputes within the meaning of this paragraph 5(b) include disputes between the Contractor (or any of its subcontractors) and the HA, HUD, the U.S. Department of Labor, or the employees or their representatives.

6. Contract Work Hours and Safety Standards Act

The provisions of this paragraph 6 are applicable only where the amount of the prime contract exceeds $100,000. As used in this paragraph, the terms "laborers" and "mechanics" includes watchmen and guards.

(a) **Overtime requirements.** No Contractor or subcontractor contracting for any part of the Contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of 40 hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of 40 hours in such workweek.

(b) **Violation; liability for unpaid wages; liquidated damages.** In the event of any violation of the provisions set forth in paragraph 6(a), the Contractor and any

subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such Contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to the District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the provisions set forth in paragraph (a) of this clause, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of 40 hours without payment of the overtime wages required by provisions set forth in paragraph (a) of this clause.

(c) **Withholding for unpaid wages and liquidated damages.** HUD or its designee shall upon its own action or upon written request of an authorized representative of the U.S. Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the Contractor or subcontractor under any such Contract or any federal contract with the same prime Contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime Contractor such sums as may be determined to be necessary to satisfy any liabilities of such Contractor or subcontractor for unpaid wages and liquidated damages as provided in the provisions set forth in paragraph (b) of this clause.

7. Subcontracts

The Contractor or subcontractor shall insert in any subcontracts all the provisions contained in this Section II and also a clause requiring the subcontractors to include these provisions in any lower tier subcontracts. The prime Contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the provisions contained in these clauses.

8. Non-Federal Prevailing Wage Rates

Any prevailing wage rate (including basic hourly rate and any fringe benefits), determined under state law to be prevailing, with respect to any employee in any trade or position employed under the Contract, is inapplicable to the contract and shall not be enforced against the Contractor or any subcontractor, with respect to employees engaged under the contract whenever such non-Federal prevailing wage rate, exclusive of any fringe benefits, exceeds the applicable wage rate determined by the Secretary of HUD to be prevailing in the locality with respect to such trade or position.

CONFLICT OF INTEREST QUESTIONNAIRE

FORM CIQ

For vendor or other person doing business with local governmental entity

This questionnaire reflects changes made to the law by H.B. 1491, 80th Leg., Regular Session.

This questionnaire is being filed in accordance with Chapter 176, Local Government Code by a person who has a business relationship as defined by Section 176.001(1-a) with a local governmental entity and the person meets requirements under Section 176.006(a).

By law this questionnaire must be filed with the records administrator of the local governmental entity not later than the 7th business day after the date the person becomes aware of facts that require the statement to be filed. *See* Section 176.006, Local Government Code.

A person commits an offense if the person knowingly violates Section 176.006, Local Government Code. An offense under this section is a Class C misdemeanor.

OFFICE USE ONLY

Date Received

1 **Name of person who has a business relationship with local governmental entity.**

2 ☐ **Check this box if you are filing an update to a previously filed questionnaire.**

(The law requires that you file an updated completed questionnaire with the appropriate filing authority not later than the 7th business day after the date the originally filed questionnaire becomes incomplete or inaccurate.)

3 **Name of local government officer with whom filer has employment or business relationship.**

_____

Name of Officer

This section (item 3 including subparts A, B, C & D) must be completed for each officer with whom the filer has an employment or other business relationship as defined by Section 176.001(1-a), Local Government Code. Attach additional pages to this Form CIQ as necessary.

A. Is the local government officer named in this section receiving or likely to receive taxable income, other than investment income, from the filer of the questionnaire?

☐ Yes ☐ No

B. Is the filer of the questionnaire receiving or likely to receive taxable income, other than investment income, from or at the direction of the local government officer named in this section AND the taxable income is not received from the local governmental entity?

☐ Yes ☐ No

C. Is the filer of this questionnaire employed by a corporation or other business entity with respect to which the local government officer serves as an officer or director, or holds an ownership of 10 percent or more?

☐ Yes ☐ No

D. Describe each employment or business relationship with the local government officer named in this section.

4

_____ _____

Signature of person doing business with the governmental entity Date

Adopted 06/29/2007

CERTIFICATE OF INTERESTED PARTIES

FORM 1295

OFFICE USE ONLY

Complete Nos. 1 - 4 and 6 if there are interested parties.
Complete Nos. 1, 2, 3, 5, and 6 if there are no interested parties.

1 Name of business entity filing form, and the city, state and country of the business entity's place of business.

2 Name of governmental entity or state agency that is a party to the contract for which the form is being filed.

3 Provide the identification number used by the governmental entity or state agency to track or identify the contract, and provide a description of the goods or services to be provided under the contract.

4 Name of Interested Party	City, State, Country (place of business)	Nature of Interest (check applicable)	
		Controlling	Intermediary

5 Check only if there is NO Interested Party. ☐

6 AFFIDAVIT

I swear, or affirm, under penalty of perjury, that the above disclosure is true and correct.

_____
Signature of authorized agent of contracting business entity

AFFIX NOTARY STAMP / SEAL ABOVE

Sworn to and subscribed before me, by the said _____, this the _____ day of _____, 20 _____ , to certify which, witness my hand and seal of office.

_____ _____ _____
Signature of officer administering oath | Printed name of officer administering oath | Title of officer administering oath

ADD ADDITIONAL PAGES AS NECESSARY

DISCLOSURE OF LOBBYING ACTIVITIES

Approved by OMB
0348-0046

Complete this form to disclose lobbying activities pursuant to 31 U.S.C. 1352
(See reverse for public burden disclosure.)

1. Type of Federal Action:	2. Status of Federal Action:	3. Report Type:
☐ a. contract b. grant c. cooperative agreement d. loan e. loan guarantee f. loan insurance	☐ a. bid/offer/application b. initial award c. post-award	☐ a. initial filing b. material change **For Material Change Only:** year _____ quarter _____ date of last report _____

4. Name and Address of Reporting Entity:	5. If Reporting Entity in No. 4 is a Subawardee, Enter Name and Address of Prime:
☐ **Prime** ☐ **Subawardee** Tier _____, *if known*: **Congressional District**, *if known*: 4c	 **Congressional District**, *if known*:
6. Federal Department/Agency:	**7. Federal Program Name/Description:** CFDA Number, *if applicable*: _____
8. Federal Action Number, *if known*:	**9. Award Amount,** *if known*: $
10. a. Name and Address of Lobbying Registrant (*if individual, last name, first name, MI*):	**b. Individuals Performing Services** (*including address if different from No. 10a*) (*last name, first name, MI*):
11. Information requested through this form is authorized by title 31 U.S.C. section 1352. This disclosure of lobbying activities is a material representation of fact upon which reliance was placed by the tier above when this transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.	Signature: _____ Print Name: _____ Title: _____ Telephone No.: _____ Date: _____
Federal Use Only:	Authorized for Local Reproduction Standard Form LLL (Rev. 7-97)

PRINT

INSTRUCTIONS FOR COMPLETION OF SF-LLL, DISCLOSURE OF LOBBYING ACTIVITIES

This disclosure form shall be completed by the reporting entity, whether subawardee or prime Federal recipient, at the initiation or receipt of a covered Federal action, or a material change to a previous filing, pursuant to title 31 U.S.C. section 1352. The filing of a form is required for each payment or agreement to make payment to any lobbying entity for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employeeof a Member of Congress in connection with a covered Federal action. Complete all items that apply for both the initial filing and material change report. Refer to the implementing guidance published by the Office of Management and Budget for additional information.

1. Identify the type of covered Federal action for which lobbying activity is and/or has been secured to influence the outcome of a covered Federal action.

2. Identify the status of the covered Federal action.

3. Identify the appropriate classification of this report. If this is a followup report caused by a material change to the information previously reported, enter the year and quarter in which the change occurred. Enter the date of the last previously submitted report by this reporting entity for this covered Federal action.

4. Enter the full name, address, city, State and zip code of the reporting entity. Include Congressional District, if known. Check the appropriate classification of the reporting entity that designates if it is, or expects to be, a prime or subaward recipient. Identify the tier of the subawardee, e.g., the first subawardee of the prime is the 1st tier. Subawards include but are not limited to subcontracts, subgrants and contract awards under grants.

5. If the organization filing the report in item 4 checks "Subawardee," then enter the full name, address, city, State and zip code of the prime Federal recipient. Include Congressional District, if known.

6. Enter the name of the Federal agency making the award or loan commitment. Include at least one organizationallevel below agency name, if known. For example, Department of Transportation, United States Coast Guard.

7. Enter the Federal program name or description for the covered Federal action (item 1). If known, enter the full Catalog of Federal Domestic Assistance (CFDA) number for grants, cooperative agreements, loans, and loan commitments.

8. Enter the most appropriate Federal identifying number available for the Federal action identified in item 1 (e.g., Request for Proposal (RFP) number; Invitation for Bid (IFB) number; grant announcement number; the contract, grant, or loan award number; the application/proposal control number assigned by the Federal agency). Include prefixes, e.g., "RFP-DE-90-001."

9. For a covered Federal action where there has been an award or loan commitment by the Federal agency, enter the Federal amount of the award/loan commitment for the prime entity identified in item 4 or 5.

10. (a) Enter the full name, address, city, State and zip code of the lobbying registrant under the Lobbying Disclosure Act of 1995 engaged by the reporting entity identified in item 4 to influence the covered Federal action.

    (b) Enter the full names of the individual(s) performing services, and include full address if different from 10 (a). Enter Last Name, First Name, and Middle Initial (MI).

11. The certifying official shall sign and date the form, print his/her name, title, and telephone number.

OMB Approval No. 2577-0157 (Exp. 01/31/2017)

Certification of Payments to Influence Federal Transactions

U.S. Department of Housing and Urban Development
Office of Public and Indian Housing

Applicant Name

Program/Activity Receiving Federal Grant Funding

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, Disclosure Form to Report Lobbying, in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all sub recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

I hereby certify that all the information stated herein, as well as any information provided in the accompaniment herewith, is true and accurate. **Warning:** HUD will prosecute false claims and statements. Conviction may result in criminal and/or civil penalties. (18 U.S.C. 1001, 1010, 1012; 31 U.S.C. 3729, 3802)

Name of Authorized Official	Title

Signature	Date (mm/dd/yyyy)

ATTACHMENT B
Profile of Firm Form
Company Biography

PROFILE OF FIRM FORM (Page 1 of 2)

(1) Prime ____ Joint Venture/Partner____ Sub-contractor _____ (This form shall be completed by and for each).

(2) Legal Name of Firm:_____

dba if applicable:_____

Telephone:_____ Fax: _____

Street Address, City, State, Zip:_____

(3) Identify Principals/Partners in Firm

NAME	TITLE	% OF OWNERSHIP

(4) Please indicate the operating structure of your company.

□ Publicly Held Corporation □ Privately Held Corporation □ Government Agency □ Non-Profit Organization □ Partnership □ Sole Proprietorship

(5) Respondents's Diversity Statement: You must check all of the following that apply to the ownership of this firm and enter where provided the correct percentage (%) of ownership of each:

Minority- (MBE), or Woman-Owned (WBE) Business Enterprises qualify by virtue of 51% or more ownership and active management by one or more of the following:

□African American □ Native American □Hispanic American □Asian/Pacific American □Hasidic Jew □Asian/Indian American

_____% _____% _____% _____% _____% _____%

□Woman-Owned (MBE) □Woman-Owned (Caucasian) □Disabled Veteran □ Caucasian American (Male) □Other (Specify):

_____% _____% _____% _____% _____%

(6) Is the business 51% or more owned by a public housing resident? ___ Yes; ___ No. If yes, provide name and address of the public housing facility:

Facility Name:_____

Facility Address:_____ City:_____

(7) SWMBE Certification Number: _____

Certification Agency: _____

(NOTE: A CERTIFICATION/NUMBER IS NOT REQUIRED – ENTER IF AVAILABLE)

(8) Federal Tax ID Number:

(9) City of San Antonio Business License No.:

(10) State of Texas License Type and No.:

PROFILE OF FIRM FORM (Page 2 of 2)

(11) Has your firm or any member of your firm been a party to litigation with a public entity? If yes, when, with whom and state the circumstances and any resolution.

(12) Has your firm or any member of your firm ever sued or been sued by the San Antonio Housing Authority or its affiliated entities? If yes, when and state the circumstances and any resolution of the lawsuit.

(13) Has your firm or any member of your firm ever had a claim brought against because of breach of contract or nonperformance? If yes, when and state the circumstances and any resolution of the matter.

(14) Debarred Statement: Has this firm, or any principal(s) ever been debarred from providing any services by the Federal Government, any state government, the State of Texas, or any local government agency within or without the State of Texas? Yes □ No □

Initials_____

If "Yes," please attach a full detailed explanation, including dates, circumstances and current status.

(15) Disclosure Statement: Does this firm or any principals thereof have any current, past personal or professional relationship with any Commissioner or Officer of SAHA? Yes □ No □

Initials_____

If "Yes," please attach a full detailed explanation, including dates, circumstances and current status.

(16) Verification Statement: The undersigned Offerer hereby states that by completing and submitting this form he/she is verifying that all information provided herein is, to the best of his/her knowledge, true and accurate, and agrees that if the SAHA discovers that any information entered herein is false, that shall entitle the SAHA to not consider nor make award or to cancel any award with the undersigned party.

Initials_____

(17) In performing this contract, the contractor(s) shall comply with any and all applicable federal, state or local laws including but not limited to: Occupational Safety & Health, Equal Employment Opportunity, Immigration and Naturalization, The Americans with Disabilities Act, State Tax and Insurance Law, and the Fair Housing Act.

Initials_____

_____	_____	_____	
Signature	**Date**	**Printed Name**	**Company**

Company Biography

Company Name:_____

Headquarters Location:_____

Field Office Locations: _____

_____

_____

_____

Business Specialty or Focus:_____

Number of Full Time Staff:_____

Founding Date and Brief History:_____

_____

_____

_____

Texas Projects and/or Clients:_____
(past & current)

_____

_____

_____

Previous Housing Authority Experience: YES_____ **NO**_____

List the Authorities:_____

_____

_____

_____

ATTACHMENT C
Section 3 Guidelines and Forms

SAN ANTONIO HOUSING AUTHORITY

SECTION 3 PROGRAM

CONTRACTOR COMPLIANCE GUIDE

BACKGROUND

The San Antonio Housing Authority (SAHA) adopted a formal Section 3 program, policy, and procedures on June 2, 2011 (Resolution 5164) to provide the framework for its compliance with Section 3 of the Housing and Urban Development (HUD) Act of 1968 which applies to all employment and economic projects funded in whole or in part by HUD.

Therefore, all prime contractors participating on a HUD-assisted project shall comply with all applicable sections of the SAHA Section 3 Program.

The objective of the SAHA Section 3 Program is to ensure to the greatest extent feasible that employment and other economic-related opportunities are directed to low- and very-low income individuals and businesses owned by such individuals.

SECTION 3 GUIDANCE

1. The SAHA Section 3 Program adopted on June 2, 2011 is hereby incorporated by reference as part of this Interim Section 3 Guidance. Notice is hereby given that it is the responsibility of bidder/proposer or contractor to ensure understanding and compliance with all applicable sections of the Section 3 Program. Bidders/proposers and/or prime contractors are directed to the SAHA website for more information on the Section 3 Program.

2. The Section 3 Program requirements apply to all HUD-assisted projects covered by Section 3 and are therefore applicable to SAHA bidders/proposers and recipients of contracts and subcontracts.

3. In order to achieve the Section 3 Program objectives, numerical goals for training/employment and subcontracting opportunities for Section 3 residents and Business Concerns have been established. The Section 3 goals (below) apply to the entire Section 3 covered project and represent minimum numerical goals set forth in the Section 3 Program. In the absence of evidence to the contrary, a contractor that meets the minimum numerical goals will be considered to have complied with the Section 3 Program requirements. SAHA reserves the right to increase project-specific goals as may be deemed appropriate by the SAHA representatives. Contractors are advised to read each solicitation carefully to determine the applicable goals for compliance. In the event the solicitation changes the goals listed below, Contractor must follow the stricter goals.

   Employment: Thirty percent (30%) of new hires per contract should be Section 3 residents.

Contracting: Subcontract ten percent (10%) of the total value of a construction contract with Section 3 Business Concerns.
Professional Services: Subcontract three percent (3%) with Section 3 Business Concerns on non-construction contracts (professional services).

3. In order to ensure the greatest impact on employment, contracting and economic opportunities, SAHA contractors and subcontractors shall direct their efforts to Section 3 residents and Business Concerns on a "preference" tiered basis as follows:

Training/Employment

a) Category 1: Residents of the housing development or developments for which the Section 3 covered assistance is expended.
b) Category 2: Residents of the other housing developments managed by the housing authority that is expending the Section 3 covered assistance.
c) Category 3: Participants in HUD Youthbuild programs being carried out in the metropolitan area in which the Section 3 covered assistance is expended.
d) Other Section 3 residents.

Contracting Opportunities

a) Category 1: Business Concerns that are 51 percent or more owned by residents of the housing development or developments for which the Section 3 covered assistance is expended, or whose full-time permanent workforce includes 30 percent of those persons as employees.
b) Category 2: Business Concerns that are 51 percent or more owned by residents of other housing developments or developments managed by the housing authority that is expending the Section 3 covered assistance, or whose full-time permanent workforce includes 30 percent of those persons as employees.
c) Category 3: HUD Youthbuild programs being carried out in the metropolitan area (or non-metropolitan county) in which the Section 3 covered assistance is expended.
d) Category 4: Business concerns that are 51 percent or more owned by Section 3 residents or whose permanent, full-time workforce includes no less than 30 percent Section 3 residents, or that subcontract in excess of 25 percent of the total amount of subcontracts to Category 1 or 2 business concerns identified above.

4. To more effectively apply the Section 3 preferences, the following incentives shall be applicable to Section 3 HUD-assisted projects:

Solicitations Under $50,000

On solicitations under $50,000 and where two or more certified Section 3 Business Concerns are available to compete, SAHA will institute a "first source" solicitation initiative whereby two of the three solicited firms must be Section 3 Business Concerns.

Solicitations Greater than $50,000

On Requests for Proposals the following incentives will be instituted:

1) A twenty percent (20%) preference will be instituted for Category 1 Section 3 Business Concerns bidding as prime contractors.
2) A fifteen percent (15%) preference will be instituted for Category 2 Section 3 Business Concerns bidding as prime contractors.
3) A ten percent (10%) preference will be instituted for Category 3 Section 3 Business Concerns bidding as prime contractors.
4) A five percent (5%) preference will be instituted for Category 4 Section 3 Business Concerns bidding as prime contractors.
5) A five percent (5%) preference will be provided to SAHA prime contractors that have achieved both the resident hires and business concern contracting goals in their immediate past contract performance within the last year.
6) A five percent (5%) preference will be provided to SAHA prime contractors participating in a SAHA approved Joint Venture or Mentor-Protégé program with an eligible Section 3 Business Concern.
7) A five percent (5%) preference will be provided to prime contractors that have formal apprenticeship programs approved by DOL and commit to training no less than ten (10) eligible Section 3 residents through such programs annually that provide no less than 250 hours of formal training.

On Invitations for Bids the following preference will be instituted:

1). Contractors who are certified as Section 3 Business Concerns and whose prices are within the independent cost estimate of the project and are both responsive and responsible, shall receive a preference according to the following table, where x is the amount by which the Section 3 Business Concern may be above the lowest responsive bid.

---

x=lesser of:

When the lowest responsive bid
is less than $100,000 10% of that bid or $9,000.

.

When the lowest responsive bid is:
At least $100,000, but less than $200,000 9% of that bid, or $16,000.
At least $200,000, but less than $300,000 8% of that bid, or $21,000.
At least $300,000, but less than $400,000 7% of that bid, or $24,000.

At least $400,000, but less than $500,000 6% of that bid, or $25,000.
At least $500,000, but less than $1 million 5% of that bid, or $40,000.
At least $1 million, but less than $2 million 4% of that bid, or $60,000.
At least $2 million, but less than $4 million 3% of that bid, or $80,000.
At least $4 million, but less than $7 million 2% of that bid, or $105,000.
$7 million or more 1\1/2\% of the lowest responsive bid, with no dollar limit.

2) Where two or more Section 3 business concerns are both responsive and responsible, the Section 3 business concern with the lowest price shall receive the contract award.

A successful contractor's usage of the above preferences shall be capped annually at $1 million dollars in the aggregate. Once a contractor has been awarded annually $1 million dollars in contracts as a result of a preference, the contractor is no longer eligible for the above preferences for the remainder of the calendar year.

5. Bidders/proposers must either achieve the Section 3 Program employment and subcontracting goals identified above (under number 3) or demonstrate acceptable good faith efforts to achieve the numerical goals in the proposal/bid. SAHA representatives shall review and deem acceptable, in their sole determination, a bidder or proposer's good faith efforts prior to the award of the contract. Please be advised that a contractor Section 3 performance will be considered and evaluated on future SAHA contracts and will be a factor in t the selection and/or contract award.

6. To ensure that the SAHA Section 3 Program benefits individuals and businesses that are eligible Section 3 residents and Business Concerns, all Section 3 resident and Business Concerns must be deemed eligible through documentation of a "Section 3 Eligibility Form" for each eligible individual or business. Notice is hereby given that it is the responsibility of the prime contractor to ensure that all participating and eligible Section 3 residents and/or Business Concerns (vendors, suppliers or subcontractors) submit the necessary information for proper SAHA status review and credit.

7. All SAHA prime contractors must submit a Section 3 program compliance report on a monthly basis in the form and content as requested by SAHA staff. This report shall document Section 3 resident and Business Concern training, employment, and subcontracting monthly performance against goals and opportunities.

8. Failure or refusal by a SAHA bidder/proposer or contractor to satisfy or comply with the Section 3 Program requirements, either during the bid/proposal process or during the term of the SAHA agreement, shall constitute a material breach of contract whereupon the contract, at the option of SAHA, may be cancelled, terminated, or suspended in whole or in part; and, the contractor debarred from further contracts with SAHA as a non-responsible contractor. SAHA may at its discretion also declare bids/proposals not complying with the Section 3 Program requirements in whole or in part nonresponsive and eliminate them from consideration of a contract award.

INTERIM PRIME CONTRACTOR COMPLIANCE REQUIREMENTS

Prime contractors participating on SAHA Section 3 HUD-assisted projects are specifically required to address and satisfy the Section 3 Program requirements described below *prior* to the award of the contract. The Section 3 Program requirements shall be applicable throughout the duration of the contract and to any amendment and renewal.

1. In the absence of evidence to the contrary, a prime contractor that meets the minimum Section 3 Program numerical goals set forth in the solicitation will be considered to have complied with the Section 3 Program requirements. A prime contractor who meets this goal must submit with the bid/proposal a "*Good Faith Effort Compliance Plan*" (**Attachment A**) by simply completing Sections A and B which present the project and contractor information and goal commitment information respectfully.

2. In evaluating compliance, a prime contractor that *has not* met the numerical goals set forth in the solicitation has the burden of fully demonstrating its efforts to achieve the Section 3 goals through the submittal and approval of a "*Good Faith Effort Compliance Plan*" (**Attachment A**) to include completion of Sections A. B and C which must be included with the bid/proposal. SAHA representatives shall review and determine in their sole discretion whether a bidder or proposer's (contractor) good faith effort compliance plan achieves the Section 3 Program goals and objectives. A responsive good faith effort compliance plan shall address all questions in Sections A, B and C and describe the concrete efforts that were taken and will be taken to reach numerical goals in hiring/employment, training, and contracting. The final agreed-upon plan shall become part of the SAHA contract.

3. SAHA reserves the right to disregard bids/proposals as non-responsive bids and proposals which fail to demonstrate a good faith effort towards compliance with the Section 3 Program requirements.

4. As required under the Section 3 Program's contractual clause, prime contractors specifically agree to include the Section 3 Clause in every subcontract subject to compliance with regulations in 24 CFR Part 135, and agree to take appropriate action, as provided in an applicable provision of the subcontract or in the Section 3 Clause, upon a finding that a subcontractor is in violation of the regulations in 24 CFR Part 135. A prime contractor shall not subcontract with any subcontractor where the bidder/proposer has notice or knowledge that the subcontractor has been found in violation of the regulations in 24 CFR Part 135.

5. Prime contractors shall submit a properly completed and executed "Section 3 Eligibility Form" for all participating Section 3 residents and/or Section 3 Business Concerns (**Attachment B**). It is the responsibility of the prime contractor to ensure that eligible Section 3 residents and Business Concerns submit all necessary information for SAHA review and credit, to include an eligible Section 3 prime contractor, if applicable.

6. Prime contractors requesting a Section 3 Program preference based upon employment or ownership interest shall submit a properly completed and executed Section 3 Eligibility Forms for all employees and owners who qualify, and provide any supporting documentation that may subsequently be required by SAHA. Prime contractors and subcontractors must employ any Section 3 residents full-time for not less than one month prior to the submittal of the bid/proposal in order for the prime contractor to receive credit for employing the Section 3 resident for a preference.

7. Notwithstanding the fact that a prime contractor may have the capability to complete a total project with its own workforce and without the use of subcontractors, all SAHA prime contractors on a HUD-assisted project shall be required to achieve the Section 3 Program numerical goals or demonstrate a good faith effort to achieve those goals within the industry. Should the need arise to hire or subcontract during the term of a contract, the hiring and/or subcontracting goals shall still be applicable and the training component remains in force.

8. All changes to the original list of subcontractors submitted with the bid or proposal shall be submitted for review and approval in accordance with SAHA's procedures when adding, changing, or deleting subcontractors/sub-consultants. Prime contractors are required to make a good faith effort to replace any Section 3 Business Concern with another eligible Section 3 Business Concern. SAHA may deny such requests when it finds that a prime contractor fails to provide acceptable justification or when the effect of such change would dilute a preference received on a HUD-assisted contract.

9. All prime contractors participating on a HUD-assisted project shall submit a Section 3 Performance Report no later than the third business day of the following month detailing Section 3 employment and contracting activity not only for themselves but also all subcontractors on the project. The report is to also detail training and other economic opportunity activities by the prime contractor and subcontractors.

SAN ANTONIO HOUSING AUTHORITY
SECTION 3 PROGRAM UTILIZATION PLAN

INSTRUCTION SHEET

Please read these instructions carefully before completing the required *Section 3 Utilization Plan* document. These instructions are designed to assist bidders/proposers document Section 3 Program compliance. or present a detailed explanation why, despite their best efforts the minimum numerical goals were not met. These numerical goals are ***minimum*** targets that must be reached in order for SAHA to consider a recipient in compliance.

Questions regarding completion of the *Section 3 Utilization Plan* document should be directed to:
Section 3 Coordinator, at 210 -477 -6165 or section3@saha.org.

- Bidders/proposers are required to make sincere efforts to achieve the Section 3 Program numerical goals as specified in solicitation documents. A bidders/proposers approved Section 3 Utilization Plan will be monitored throughout the duration of the SAHA contractual term.

- Contractor shall submit a *Section 3 Utilization Plan* at the time of bid/proposal submittal in order to be considered responsive.

- This *Section 3 Utilization Plan* is subject to SAHA's review and approval. SAHA may at its sole discretion approve or disapprove the plan. SAHA's determination is administratively appealable to the CEO and to the Board of Commissioners pursuant to SAHA's Section 3 Program, Policy & Procedures.

- All bidders/proposers are to complete the following:

_____ **Section A,** Bidder/Proposer Information

_____ **Section B,** Contractor Commitments - New Hires

_____ **Section C,** Contractor Commitments - Subcontractors

_____ **Section D,** Contractor Commitments – Other Economic Opportunities

_____ **Section E,** Good Faith Efforts

_____ **Section F,** Section 3 Compliance Certification

Optional:

_____ Certification for Section 3 Business Concerns

_____ Section 3 Individual Verification Form (S3-6003b REV 2/2016)

- SAHA requires all Section 3 residents and/or Business Concerns to certify or submit evidence to SAHA, contractor, or subcontractor, that the person or business is Section 3 eligible. SAHA has developed a Certification Process for this purpose. It is the responsibility of the Contractor to submit these forms to the SAHA Section 3 Coordinator at section3@saha.org.

SECTION 3 PROGRAM UTILIZATION PLAN

Project Title: _____

SECTION A – BIDDER/PROPOSER INFORMATION

Name of Firm: _____

Contact Person: _____ Telephone: _____

Email: _____

Is your firm a "Section 3 Business Concern": Yes _____ No_____
If "Yes"; complete the Certification for Section 3 Business Form and attach the Required Documentation.

SECTION B – CONTRACTOR COMMITMENTS – NEW HIRES (If more space is needed, please provide an attachment).

Hiring Goal: A minimum of Thirty percent (30%) of the aggregate number of new hires shall be Section 3 residents

B.1 Explain how you intend to recruit a minimum of 30% of Section 3 residents for **full-time new hires**, and what actions you will use to require subcontractors to do the same. **Note**: Section 3 individuals must work a minimum of 32 hours per week or 135 hours per month to be considered full-time employees.

B.2 Complete the table below to identify the bidder's/proposer's employee positions required for the execution of this project**.**

Job Category*	Number of Positions to be Filled with Section 3 Residents	Anticipated wages per hour
Professionals		
Technicians		
Office/Clerical		
Officers/Managers		
Sales		
Craft Workers (Skilled)		
Operatives (Semi-Skilled)		
Laborers (Unskilled)		
Service Workers		
Other List & describe		

B.3 The contractor has committed to employ _____ resident(s) in order to comply with its Section 3 requirements. Indicate the estimated percentage of Section 3 new hires for this project: _____

SECTION C – CONTRACTOR COMMITMENTS – SUBCONTRACTORS (If more space is needed, please provide an attachment).

Contracting Goal: A minimum of ten percent (10%) of all covered **construction** contracts shall be awarded to Section 3 business concerns C. Three percent (3%) of all covered **non-construction** contracts shall be awarded to Section 3 business concerns

C.1 Describe how bids from Section 3 businesses will be solicited for subcontracting.

C.2 Complete the table below to identify the subcontractors/suppliers that will be utilized for the execution of this project**.**

Subcontractor/Supplier Listing

Subcontractor or Supplier/ Name and Address and phone number	Scope of Work/Product	$ Value	Certified Section 3 Business Concern (Y/N)

(*Make Additional Copies as Necessary*)

C.3 The Prime Contractor will subcontract with a total of _____ Section 3 Business Concerns totaling _____% of the Contract Value. ***NOTE:*** *The contractual opportunity goal is a percentage of the total gross dollar value of the proposed contract awarded to a Section 3 eligible Business Concern. SAHA will only credit participation by Section 3 Business Concerns that submit documentation acceptable to SAHA certifying their Section 3 status.*

SECTION D – CONTRACTOR COMMITMENTS – OTHER ECONOMIC OPPORTUNITIES (If more space is needed, please provide an attachment).

B.3 The undersigned bidder/proposer will satisfy the Section 3 *other economic opportunity* goal:
Yes _____ No_____

Please outline your plan to provide other economic opportunities to Section 3 residents. Examples of plans may include training agreements, internship programs, mentorship programs etc.

SECTION E – GOOD FAITH EFFORTS

NOTE: Fill this section only, if Plan as submitted fails to meet the employment and contractual opportunity goals as stated herein or as amended in the solicitation.

D.1 If no contracting, hiring or other economic opportunities are anticipated, briefly explain why.

SECTION F: SECTION 3 UTILIZATION PLAN CERTIFICATION

I CERTIFY THAT I HAVE REVIEWED AND FULLY UNDERSTAND SAHA'S SECTION 3 PROGRAM AND THE SECTION 3 CLAUSE INCORPORATED BY REFERENCE INTO THIS DOCUMENT. I HEREBY AFFIRM THAT THE INFORMATION SUBMITTED HEREIN IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.
I HEREBY CERTIFYTHAT THE ABOVE TABLES IDENTIFY THE NUMBER OF SECTION 3 BUSINESS CONCERNS THE COMPANY WILL UTILIZE AND THE NUMBER OF SECTION 3 RESIDENTS THE COMPANY PROPOSES TO EMPLOY.
I FURTHER UNDERSTAND AND AGREE THAT, THIS DOCUMENT SHALL BE ATTACHED THERETO AND BECOME A BINDING PART OF THE SAHA CONTRACT.

NAME AND TITLE OF AUTHORIZED OFFICIAL:
_____

SIGNATURE: _____ DATE: _____

San Antonio Housing Authority

Section 3 Individual New Hire Verification Form

NEW HIRES MUST COMPLETE THIS FORM. The Section 3 Program requires that recipients of certain HUD financial assistance, to the greatest extent feasible provide employment, training or education opportunities for low- and very-low income persons in connection with projects and activities in their neighborhood. Completion of this form helps your new employer and SAHA monitor compliance to the Section 3 program and may help in obtaining future business with the Housing Authority. Your information is kept CONFIDENTIAL and will not affect any federal subsidies you currently receive, if any.

CONTACT INFORMATION

First Name:	Last:	M.I:	Suffix:
Residence Address:	City:		
State:	Zip:	County:	Phone:
Email Address (required):		DOB:	
Date of Hire:	Company Name:		
Job Title:	Type of job: ◯ Full-Time (32+ hours per week) ◯ Part-Time		

INCOME DISCLOSURE (CHECK ONE OPTION BELOW)

In order to be eligible as a Section 3 individual, your household income must meet the income criteria by household size. Individuals are eligible for Section 3 status if their household income is at or below 80% of Area Median Income in Bexar County during the current calendar year or be a resident of public housing or Section 8.

◯ **Option 1:** I choose to disclose this information

Choose the number of individuals in your household in the chart below to determine your HUD income limit. The dollar amount below the number you indicate is your HUD income limit.

FY 2019 80% Area Median Income Limits (by Household Size)

Number of persons in household	1	2	3	4	5	6	7	8
80% of Area Median Income (FY 2020 HUD Income Limits)	$40,350 ◯	$46,100 ◯	$51,850 ◯	$57,600 ◯	$62,250 ◯	$66,850 ◯	$71,450 ◯	$76,050 ◯

YOU MUST ANSWER THE FOLLOWING QUESTIONS IF YOU ARE CLAIMING SECTION 3 ELIGIBILITY:

Is your household income at or below the HUD income limit for the current year? ◯ **Yes** ◯ **No**

If your answer is YES and you reside in Bexar County, you are a Section 3 individual, regardless of public housing status.

Are you a resident of public housing or Section 8? ◯ **Yes** ◯ **No**

If your answer is YES, you are a Section 3 individual regardless of your income.

◯ **Option 2:** I choose NOT to disclose this information OR I do not qualify as a Section 3 eligible individual.

CERTIFICATION

By signing, I authorize my employer to release relevant information to the San Antonio Housing Authority (SAHA) for contract compliance purposes. I further affirm that the information on this form is to the best of my knowledge and belief true, correct, and complete.

Signature_____ DATE: _____

M/WBE UTILIZATION STATEMENT
SAN ANTONIO HOUSING AUTHORITY
M/WBE PROGRAM OFFICE

Please read these instructions carefully before completing the required Minority/Women Business Enterprise (M/WBE) Utilization Statement. These instructions are designed to assist prime contractors/consultants document M/WBE program compliance or in preparing the required detailed and complete good faith effort information.

Contractors/Consultants are required to submit detailed documentation when the contract specified M/WBE participation ranges or goals are not met. The SAHA M/WBE Program Manager will review and consider a bidder's or proposer's good faith efforts in assisting SAHA to meet its M/WBE policy and program objectives.

A. Bidders/Proposers are required to make sincere efforts in attempting to achieve the applicable SAHA M/WBE participation ranges or goals. The approved M/WBE participation ranges or goals will be monitored throughout the duration of the project;

B. All bidders/proposers are to complete Section A, Project Identification and Section B, Project M/WBE Utilization, if applicable. Should there be subcontracting/sub consulting opportunities, yet the bidder/proposer *not* achieve the project's applicable M/WBE participation range or goal, the bidder/proposer must complete all other sections of the Statement.

C. This Statement should be prepared by the company's project M/WBE Coordinator or designee. The Statement must be signed and dated by an authorized company official. The Coordinator or designee should have a working knowledge as to the project's subcontracting or sub-consulting and supplier activities (actual and anticipated). This individual shall be a key figure in directing the prime contractor's M/WBE activities.

D. The M/WBE Utilization Statement demonstrating a contractor's good faith efforts is subject to the SAHA M/WBE Program Coordinator's review and approval.

E. SAHA requires all M/WBE firms to be certified as such by an entity acceptable to SAHA for project M/WBE credit.

F. SAHA reserves the right to approve all additions or deletions of subcontractors, subconsultants, and/or major vendors. In the event that an M/WBE subcontractor, subconsultant, and/or major vendor is replaced, the contractor must make a good faith effort to involve and utilize another M/WBE subcontractor, sub consultant, and/or major vendor.

Should you have any questions or need additional information, please contact:

Candace Morin
818 S Flores
Section 3/SWMBE Coordinator
candace_morin@saha.org
210-477-6165

FOR SAHA PROCUREMENT DEPARTMENT USE ONLY
Reviewed by: _____
Date: _____
Signature of SAHA Official: _____
Recommendation: Approval: _____ Denial: _____
subject to the SAHA M/WBE Program Manager's review and approval.

M/WBE UTILIZATION STATEMENT
SAN ANTONIO HOUSING AUTHORITY
M/WBE PROGRAM OFFICE

SECTION A: PROJECT IDENTIFICATION

Project Number_____ Project Title_____

Contract Amount _____ Company Name _____

Project Participation Range/Goal: M/WBE ____ %

Contract Anticipated Participation Range: M/WBE ____ %

The M/WBE participation range/goal is expressed as a percentage of the total dollar amount of the prime contract awarded to M/WBEs. The goal is applicable for those areas, which the prime contractor has subcontracted, sub-consulted, and/or major supplies necessary in the performance of the contract.

SECTION B: SUBCONTRACTOR/SUB CONSULTANT/VENDOR UTILIZATION

1. List all actual *and* anticipated subcontracts, subconsultants, and/or major material purchases, include *both* M/WBE and non-M/WBE, to be utilized on the project (*use additional sheets if necessary*).

TRADE AREA	ESTIMATED AMOUNT ($)	SUB/SUPPLIER	SUB/SUPPLIER M/WBE Yes (√) No	

2. MBE utilization in total dollars: _____ WBE utilization in total dollars: _____
3. Overall MBE utilization percentage (%): _____
4. Overall WBE utilization percentage (%): _____
5. Overall M/WBE utilization percentage (%): _____
6. Anticipated M/WBE utilization on this contract will occur:
Throughout ___ Beginning 1/3 ___ Middle 1/3 ___ Final 1/3 ___

Please Note: SAHA will credit only those M/WBEs that have been certified by an entity acceptable to SAHA. All changes, additions, or deletions occurring during the life of this contract relative to use of the listed subcontractors, sub-consultants and/or

major suppliers, M/WBE or otherwise, must be submitted to SAHA for review and approval.

If Bidder/Proposer is unable to meet the M/WBE participation range/goal, please
proceed to complete Section C and submit documentation demonstrating contractual good faith efforts.

SECTION C: GOOD FAITH EFFORT

The following items are minimally considered as good faith efforts and demonstrate specific initiatives made in attempting to achieve SAHA's M/W/BE participation ranges. The bidder/proposer is not limited to these particular areas and may include other efforts deemed appropriate. Please feel free to elaborate on any question below.

Required Questions	Yes	No
1. If applicable, was your company represented at the pre-bid conference?		
2. Did your company request and obtain a copy of the certified M/WBE firms?		
3. Were M/WBE firms solicited for contract participation?		
4. Provide listing of solicited M/WBEs with whom contact was made? Please identify name of company, contact person, date, phone number and briefly describe nature of solicitation. **(Include as an Attachment)**		
5. Was direct contact made with SAHA's M/WBE Program Office? If yes, please identify date/person contacted and assistance sought. **(Include as an Attachment)**		
6. Identify all M/WBE support agencies/associations contacted for M/WBE assistance or solicitation (Minority Chamber's of Commerce, purchasing councils, contractor groups, etc.). **(Please attach copies of solicitation letters of assistance and/or describe, as an Attachment to this section, the personal contact made)**		
7. Were bid opportunities related to this project advertised in minority/women newspapers and trade journals? **(If yes, please include a copy of the advertisement or detail the name of the publication(s), date of advertisement and describe the solicitation)**		
8. Were copies of plans and specification furnished to any M/WBEs?		
9. Were subcontractors, subconsultants, and/or suppliers (if applicable) required to provide insurance or be bonded? **(If yes, please detail any assistance that was provided or if they were referred, to whom)**		
10. List, as an Attachment, all M/WBE bids received but rejected. Identify company name, contact person, telephone number, date, trade area, and the reason for rejecting the bid/proposal.		
11. Discuss any other effort(s) aimed at involving M/WBEs (Include as an Attachment): (a) Identify any specific efforts to divide work, in accordance with normal industry practices, to allow maximum M/WBE participation.		

(b) Discuss joint ventures initiatives, requesting second-tier M/WBE subcontracting, etc., if any. (c) List all other good faith efforts employed, please elaborate.		

The undersigned acknowledges and states that all information submitted as part of this Good Faith Effort Statement is true and correct to the best of his/her knowledge. I further agree that this document shall be attached thereto and become a binding part of the SAHA contract.

_____	_____
Print Name	***Title Date***
_____	_____
Signature	***Telephone Number***

ATTACHMENT D
Proposal Checklist and Certification

PROPOSAL Checklist and Certification

(Attachment D)

(This Form must be fully completed and placed under Tab No. 8 of the proposal submitted.)

Instructions: Unless otherwise specifically required, the items listed below must be completed and included in the proposal submittal. Please complete this form by marking an "X," where provided, to verify that the referenced completed form or information has been included within the "hard copy" proposal submittal submitted by the Respondents. Also, complete the Section 3 Statement and the Respondent's Statement as noted below:

X=ITEM INCLUDED	SUBMITTAL ITEMS
_____	Tab 1 Profile of Firm, Company Biography
_____	Tab 2 Project Approach & Capacity
_____	Tab 3 Experience
_____	Tab 4 Compensation
_____	
_____	Tab 5 HUD Forms, Conflict of Interest Questionnaire and Form 1295
_____	Tab 6 Section 3 Business Preference
_____	Tab 7 Small/Minority/Disadvantaged/Veteran Business Enterprise Utilization Plan
_____	Tab 8 Section 3 Good Faith Effort Compliance Plan
_____	Tab 9 Proposal Checklist and Certification
_____	Tab 10 Form of Proposal

SECTION 3 STATEMENT

Are you claiming a Section 3 business preference? YES___ or NO____. If "YES," pursuant to the documentation justifying such submitted under Tab No. 8, which category are you claiming?

_____ Category I – Owned by a public housing resident where work is performed

_____ Category II – Owned by any other public housing resident

_____ Category III – HUD Youth Build Program

_____ Category IV – 30% of workforce is Section 3 qualified or subcontract greater than 25% of contract value to certified Section 3 Business Concern

Respondent's Certification

By signing below, Respondent certifies that the following statements are true and correct:

1. He/she has full authority to bind Respondents and that no member of Respondent's organization is disbarred, suspended or otherwise prohibited from contracting with any federal, state or local agency,

2. Items for which Proposals were provided herein will be delivered as specified in the Proposal,

3. In performing this contract, the contractor(s) shall comply with any and all applicable federal, state or local laws including but not limited to: Occupational Safety & Health, Equal Employment Opportunity, Immigration and Naturalization, The Americans with Disabilities Act, State Tax and Insurance Law, and the Fair Housing Act.,

4. Respondents agrees that this proposal shall remain open and valid for at least a period of 90 days from the date of the Proposal Opening and that this Proposal shall constitute an offer, which, if accepted by SAHA and subject to the terms and conditions of such acceptance, shall result in a contract between SAHA and the undersigned Respondents,

5. He/she has not given, offered to give, nor intends to give at any time hereafter any economic opportunity, future employment, gift, loan, gratuity, special discount, trip, favor, or service to a public servant in connection with this Proposal,

6. Respondents, nor the firm, corporation, partnership, or institution represented by the Respondents, or anyone acting for such firm, corporation or institution has violated the antitrust laws of the State of Texas or the Federal Antitrust laws, nor communicated directly or indirectly the Proposal made to any competitor or any other person engaged in such line of business,

7. Respondents has not received compensation for participation in the preparation of the specifications for this RFP,

8. Non-Collusive Affidavit: The undersigned party submitting this Proposal hereby certifies that such Proposal is genuine and not collusive and that said Respondents has not colluded, conspired, connived or agreed, directly or indirectly, with any Respondents or person, to put in a sham Proposal or to refrain from bidding, and has not in any manner, directly or indirectly sought by agreement or collusion, or communication or conference, with any person, to fix the Proposal price of affiant or of any other Respondents, to fix overhead, profit or cost element of said Proposal price, or that of any other Respondents or to secure any advantage against SAHA or any person interested in the proposed contract; and that all statements in said Proposal are true.

9. Child Support**:** Pursuant to Section 231.006 (d) of the Texas Family Code, regarding child support, the bidder certifies that the individual or business entity named in this bid is not ineligible to receive the specified payment and acknowledges that this contract may be terminated and payment may be withheld if this certification is inaccurate.

10. Lobbying Prohibition**:** The Contractor agrees to comply with Section 1352 of Title 31, United States Code which prohibits the use of Federal appropriated funds to pay any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with any of the following covered Federal actions: the awarding of any Federal contract; the making of any Federal grant; the making of any Federal loan; the entering into of any cooperative agreement; or the modification of any Federal contract, grant, loan, or cooperative agreement.

11. Non-Boycott of Israel: SAHA may not enter into a contract with a company for goods and services unless the contract contains a written verification from the company that; (i) it does not Boycott Israel; and (ii) will not Boycott Israel during the term of the contract. (Texas Government Code chapter 2270) by accepting these General Conditions and any associated contract, the Contractor certifies that it does not Boycott Israel, and agrees that during the term of this contract will not Boycott Israel as that term is defined in the Texas Government Code Section 808.001, as amended.

12. **TX Gov. Code 2252.152:** Prohibits a government entity from awarding a contract to a company identified as Iran, Sudan, or a Foreign Terrorist Organization as identified on a list maintained by the Texas Comptroller of Public Accounts. By signature hereon bidder certifies that it is not affiliated in any manner with the businesses on this list.

ATTACHMENT E
Form of Proposal

San Antonio Housing Authority
818 S. Flores
San Antonio, Texas 78204

Attention: Lucio Tovar, Contract Specialist

RE: Construction Management/Commissioning Agent - EPC II

RFP No. ***2006-961-14-5035***

Gentlemen:

The undersigned Respondent, having read and examined the Scope, Exhibits A-C and associated RFP Documents for the ***Construction Management/Commissioning Agent - EPC II Services*** and having visited and/or familiarized myself with the work of the proposed project and after thoroughly considering the factors which will affect the execution of the project and the cost thereof, does hereby submit this Proposal. All prices stated herein are firm and shall not be subject to escalation provided this Proposal is accepted within one hundred eighty (180) days after the official opening of proposals.

The undersigned hereby declares that the following list states any and all variations from and exceptions to the requirements of the request for proposals and that, otherwise, it is the intent of this Proposal that the Project will be performed in strict accordance with the subsequent Contract Documents.
(If no exceptions are taken, indicate so by entering "None").

_____
_____
_____
_____
_____
_____
_____

(Continue on separate page, if necessary, and attach hereto)

The undersigned Respondent in accordance with the Texas Tax Code Section 151.309 and all amendments thereto, and Volume 34 Texas Administrative Code Section 3.291 (Supp. 1994) and all amendments thereto, hereby proposes to provide the Goods and Services hereunder in accordance with the Minimum Requirements of HUD regulations 24 CFR 982, this RFP, and associated Contract Documents, for the following Contract Price for Collection Services Agency Wide in the Proposal Fee Sheet (Exhibit I).

If this Proposal is accepted, the undersigned Respondent agrees to start and to complete the Project in accordance with the schedule set forth in the subsequent Contract. It is understood that all services shall be complete and all reports shall be delivered as scheduled. The undersigned fully understands that the time of completion is of the essence of the Contract.

If written notice of the acceptance of this proposal is mailed, facsimilied, or delivered to the undersigned within one hundred eighty (180) days after the date of opening of proposals, or anytime thereafter before this proposal is withdrawn by the Respondent, the undersigned will, within ten (10) days after the date of mailing, facsimiling, or delivering of such notice, execute and deliver a Contract in the form provided by SAHA, complete with acceptable Performance and Payment Bonds, if applicable.

Dated this _____ day of _____, 20_____.

Offeror _____

By _____

Title _____

ATTEST:_____

Business Address of Offeror _____

State of Incorporation _____

Address of Principal Office_____

Email:_____

Exhibit D
Proposal Fee Sheet

1. Construction Management/Commissioning Agent - EPC II.

Description	Fee
Fully Burden Fee to complete the scope of work outlined in this RFP.	$

Addenda Acknowledgements

Addendum #1_____ Date_____

Addendum #2_____ Date_____

Addendum #3_____ Date_____

Addendum #4_____ Date_____

_____ _____
Signature **Date**

_____ _____
Printed Name **Company**

_____
E-mail address if available

_____ _____
Phone **Fax**

EXHIBIT E
Insurance Requirements

Developer is required to have in place during the term of the contract the following minimum insurance requirements. Developer will be required to provide an original Certificate of Insurance to SAHA within 10 days of contract signature:

Professional Liability	**Required Limits**
SAHA and its affiliates must be named as a Certificate Holder. This is required for vendors who render observational services to SAHA such as appraisers, inspectors, attorneys, engineers or consultants.	$1,000,000
Business Automobile Liability	**Required Limits**
SAHA and its affiliates must be named as an additional insured and as the certificate holder. This is required for any vendor that will be using their vehicle to do work on SAHA properties.	$500,000 combined Single limit, Per occurrence
Workers Compensation and Employer's Liability	**Required Limits**
Workers' Compensation coverage is Statutory and has no pre-set limits. Employer's Liability limit is $500,000. Workers' Compensation is required for any vendor made up of more than two persons. ***A Waiver of Subrogation in favor of SAHA must be included in the Workers' Compensation policy.*** SAHA and its affiliates must be a Certificate Holder.	**Statutory** Employer's Liability is $500,000
Commercial General Liability	**Required Limits**
This is required for any vendor who will be doing hands on work at SAHA properties. SAHA and its affiliates must be named as an Additional Insured and as the Certificate Holder.	$1,000,000 per accident $2,000,000 aggregate