COUNTY OF KINGS

# DEPARTMENT OF PUBLIC WORKS

Kings County Government Center
1400 W. Lacey Boulevard
Hanford, CA 93230
Phone: (559) 582-3211
Extension: 2690
FAX: (559) 582-2506

Jim Henderson, Director

July 2, 2025

**ADDENDUM 1**
**FOR:**

## BID #2025-34 – Kings County Hanford and Lemoore Branch Library Remodel Project

The following additions, deletions, and/or clarifications in, on, and to the Drawings, Specifications, and Contract Documents will apply to the proposal made for, and to the execution of, the various parts of the work affected.

Careful note of the Addendum shall be taken by all parties of interest, so that the proper allowance may be made in all computations, estimates and contracts, and all trades affected shall be fully advised in the performance of the work which will be required of them.

The documents applicable to this Bid include the Drawings and the manual containing Contract Documents and Specifications.

All of the documents listed above apply to this Bid, unless modified by this Addendum. In case of conflict between Drawings, Specifications, and this Addendum, this Addendum shall govern. All other requirements of the Contract Documents shall remain the same.

Acknowledge receipt of this Addendum by inserting its number and date in the Bid Proposal.

Mitchel Cabrera, P.E.
Chief Engineer, Division of Engineering
Department of Public Works

COUNTY OF KINGS

# DEPARTMENT OF PUBLIC WORKS

Kings County Government Center
1400 W. Lacey Boulevard
Hanford, CA 93230
Phone: (559) 582-3211
Extension: 2690
FAX: (559) 582-2506

Jim Henderson, Director

**Item 1**: **Please see attachment 1 for a copy of the job walk sign in sheet.**

**Item 2**: **Would Dunn-Edwards Paints be considered an acceptable paint manufacturer, assuming the proposed products meet or exceed the specified performance standards under the Division 09 90 00 section?**

- Yes, it is an acceptable substitution as long as it meets or exceeds the specified product and warranty requirements outlined in the specifications.

**Item 3: Note #1 on sheet M0.03 requires the mechanical bidders to "... inspect & test unit is fully functional. Contractor shall also clean & REPALCE ANY WORN PARTS." Please provide a detailed list of parts that need to be replaced.**

- It is for the contractor to determine upon inspection and testing of the existing equipment if anything needs to be replaced. Bidders may include a line item in their bid as a placeholder for inspection/testing of equipment and another for replacement of miscellaneous parts.

**Item 4: What is the engineers estimate?**

| | Grant Funded | Non-Grant Funded |
|---|---|---|
| **Hanford Library** | **8,156,000** | **1,304,000** |
| **Lemoore Library** | **4,749,000** | **424,000** |

**Item 5: What is the construction budget?**

- Refer to item 4.

**Item 6: What is the funding breakdown for each library branch?**

- Refer to item 4.

**Item 7: Does this project have two DIR numbers?**

- This project has one DIR number.

**Item 8**: **Received a product alternate request for IB PVC Single Ply 60 Mil.**

- Yes, it is an acceptable substitution as long as it meets or exceeds the specified product and warranty requirements outlined in the specifications.

**Item 9**: **Received a product alternate request for SUNFLEX SF 75 in lieu of Nanawall NW 840.**

- Yes, it is an acceptable substitution as long as it meets or exceeds the specified product and warranty requirements outlined in the specifications.

COUNTY OF KINGS

DEPARTMENT OF PUBLIC WORKS

Kings County Government Center
1400 W. Lacey Boulevard
Hanford, CA 93230
Phone: (559) 582-3211
Extension: 2690
FAX: (559) 582-2506

Jim Henderson, Director

**Item 10**: **Will there be a second opportunity to attend a mandatory pre-bid meeting?**

- No.

**Item 11**: **Do you have Union Requirements?**

- There are prevailing wage requirements. This can be found in Specifications Section 001000 Notice to Contractors under Prevailing Wage Provision and Specifications Section 007200 General Conditions under 3.5.3 Wage Rates.

**Item 12**: **The specifications posted on the Builders Exchange, along with the bid packet, have watermarks stating, "Downloaded from PublicPurchase.com." Can you please confirm if these are the correct documents to be used for the bid?**

- Yes.

**Item 13**: **Will the sheriffs substation need to stay in operation during construction?**

- No, the sheriffs substation will be relocated during construction.

**Item 14: Please see attachment 2 for copies of the asbestos reports.**

**Item 15: Will the elevator in the Hanford Branch be in operation during construction?**

- Yes, the elevator can be in operation during construction, contractor is responsible for maintaining operation of elevator through the duration of construction.

**Item 16: Can the asbestos in the flooring be encapsulated?**

- Yes.

**Item 17: Will either the Hanford or Lemoore Branch libraries be in operation during construction?**

- No, both the Hanford and Lemoore Branch will be closed during construction.

**Item 18: Is it one bid for both the Hanford and Lemoore Branch?**

- Yes.

**Item 19: Please see attachment 3 for HVAC equipment located on the roof of the Lemoore Branch Library to be salvaged and removed by the County.**

**Item 20: As it relates to the BAS controls, the existing BAS at Kings County is Schneider Electric EcoStruxure. Specification section 23 09 00 Part 2.01 lists 11 different controls manufacturers for this project. Currently, the existing Schneider Electric system is a county wide BAS that communicates and controls all existing buildings in the county. In an effort to ensure compatibility with the existing**

COUNTY OF KINGS

DEPARTMENT OF PUBLIC WORKS

Kings County Government Center
1400 W. Lacey Boulevard
Hanford, CA 93230
Phone: (559) 582-3211
Extension: 2690
FAX: (559) 582-2506

Jim Henderson, Director

**enterprise level BAS, we recommend that the only allowed manufacturer for this project shall be Schneider Electric. The other brands listed in the specifications will not be compatible to connect back to the Schneider EcoStruxure BAS. All controls contractors shall provide certifications upon time of bid that show they are an approved Schneider Electric partner in the central valley.**

- Specification 23 90 00 for both Hanford and Lemoore has been updated. Please see attachment 4 for updated specifications.

**End of Addendum 1.**

**Attachments:**

1. Job Walk Sign in Sheet
2. Asbestos Reports
3. HVAC Equipment to be salvaged and saved by County
4. Specification 23 90 00

# ATTACHMENT 1

## SIGN-IN SHEET

**County of Kings Bid #2025-34**
**Hanford and Lemoore Libraries Remodel Project**

**June 17, 2025 10:00 AM**

| No | Name | Company | Email | Phone # | Fax# |
|---|---|---|---|---|---|
| 25 | Doug Tucker | Katch | doug@katchgeneral.com | (559) 835 - 6674 ext. | ( ) - ext. |
| 26 | Jordan Vasquez | Bowen Engineering | office@bowendemo.com | (559) 233 - 7464 ext. | ( ) - ext. |
| 27 | Tyler Thomas | Bush Con | TThomas@Bushconstruction.net | (559) 288 2697 ext. | ( ) - ext. |
| 28 | Mike Iranto | Emcor | mirranto@emcor.net | (559) 894 - 8848 ext. | ( ) - ext. |
| 29 | Kevin Keeling | Emcor | KKEELING@EMCOR.NET | (559) 351 - 1446 ext. | ( ) - ext. |
| 30 | Gavin Silva | BDM, INC. | ESTIMATING@BDMINC.NET | (559) 554 - 5848 ext. | ( ) - ext. |
| 31 | | | | ( ) - ext. | ( ) - ext. |
| 32 | | | | ( ) - ext. | ( ) - ext. |
| 33 | | | | ( ) - ext. | ( ) - ext. |
| 34 | | | | ( ) - ext. | ( ) - ext. |
| 35 | | | | ( ) - ext. | ( ) - ext. |
| 36 | | | | ( ) - ext. | ( ) - ext. |
| 37 | | | | ( ) - ext. | ( ) - ext. |

County of Kings Bid #2025-34
Hanford and Lemoore Libraries Remodel Project

# SIGN-IN SHEET

June 17, 2025 10:00 AM

| No | Name | Company | Email | Phone # | Fax# |
|---|---|---|---|---|---|
| 1 | Rudy FRANCO | ACM ENVIRONMENTAL | franco@environmentalca.com | (559) 755 - 4416 ext. | ( ) - ext. |
| 2 | Carlos Rodriguez | Sierra Range Const. | Carlos@sierrarange.com | (559) 635 - 0504 ext. | ( ) - ext. |
| 3 | Jose Sandoval | BMY Construction | estimating@bmyinc.com | (559) 243 - 4200 ext. | ( ) - ext. |
| 4 | Corey Reeve | Durham Constr | ramon@durham-construction | 559 294 - 9500 ext. | ( ) - ext. |
| 5 | Andy Brooks | HD Matthews Demolition | jr@hdmdinc.com | (559) 481 - 5884 ext. | ( ) - ext. |
| 6 | BO Gill | Rakkan Development & Construction | Taj@RDCFRESNO.COM | (559) 994 - 9482 ext. | ( ) - ext. |
| 7 | Manuel Buenaventa<br>Wade Sousa | 4C Global<br>4C Global | estimating@4-creeks.com<br>Wades@4-creeks.com | (559) 802 - 3052<br>ext. 559 737 0111 | ( ) - ext. |
| 8 | Forrest Brown | 4C Group | Forrestb@4-CREEKS.com | (559) 333 - 4644 ext. | ( ) - ext. |
| 9 | Fresno Roofing Jose Gama | Fresno Roofing | Jose@fresnoroofing.net | (559) 246 - 0525 ext. | ( ) - ext. |
| 10 | EDUARDO LOPEZ | SWINERTON | eduardo.lopez@SWINERTON.COM | (916) 917-517-0113 ext. | ( ) - ext. |
| 11 | | | | ( ) - ext. | ( ) - ext. |
| 12 | | | | ( ) - ext. | ( ) - ext. |

# ATTACHMENT 2

## Sampling Site: Hanford Branch Kings County Library
## 401 N. Douty St, Hanford, CA
## B207-24

ASBESTOS ANALYSIS RESULTS

A total of 26 samples of suspect materials were collected by a state certified asbestos inspector from the **Hanford Branch Kings County Library** at **401 N. Douty St, Hanford, CA**. The sample collection areas were determined by the information given to the inspector by **Megan Ulibarri of the Kings County Public Works Department** about the impending remodel/renovation that is planned for this building. McCall and Spero Environmental, Inc., a NVLAP accredited laboratory performed a total of **42** analyses from the **26** samples collected. The chain of custody from Leon Environmental Services and the report from McCall and Spero contain a full list of all samples taken from this site.

## Samples Positive for Asbestos

| Sample | Location | Material | % Of ACM | Friable |
|---|---|---|---|---|
| 01,16, 19 | Hallway, 2nd Break Room, 2nd Floor Conference Room Floor | Green 9x9 Floor Tile | 2% | No |
| | | Black Mastic | 2% | No |
| 02,17 | Hallway, 2nd Break Room Floor | White 9x9 Floor Tile | 2% | No |
| | | Black Mastic | 2% | No |

## Samples Negative for Asbestos

| Sample | Location | Material | % Of ACM | Friable |
|---|---|---|---|---|
| 03,18 | Storage Room, 2nd Floor Conference Room Floor | Carpet Glue | ND | |
| 04 | Supply Closet Floor | Grout | ND | |
| 05 | Supply Closet Floor | Thin Set | ND | |
| 06 | Stair Hallway Floor | Blue 16x16 Floor Tile | ND | |
| | | Adhesive | ND | |
| 07,20 | Stair Hallway, 2nd Floor Conference Room Wall | Beige Base Cove Mastic | ND | |

## <u>Sampling Site</u>: Hanford Branch Kings County Library
## 401 N. Douty St, Hanford, CA
## B207-24

| | | | | |
|---|---|---|---|---|
| 08,09, 10,12, 21,23, 24 | Restroom Entry, Storage Room, Hallway, Supply Closet, 2nd Floor Men's Restroom, 2nd Floor Conference Room, 2nd Floor Break Room Wall | Texture/ Color Coat | ND | |
| | | Plaster | ND | |
| 13,14, 15 | Main Room Lower Ceiling | Spray Acoustic | ND | |
| 11,25 | Supply Closet, 2nd Floor Conference Room Ceiling | 1x1 Acoustic Ceiling Tile | ND | |
| 26 | 2nd Floor Conference Room Suspended Ceiling | 2x4 Acoustic Ceiling Panel | ND | |

* Determined after composite sampling with associated sheetrock
NS – Not Sampled

### COMMENTS AND RECOMMENDATIONS

***Non-Friable Asbestos***

***<u>The Green & White 9x9 Floor Tiles</u>*** (samples 01, 02, 16, 17, 19) located on the floor throughout the building is positive for asbestos at 2%.
***<u>The Black Mastic</u>*** (sample 01,02,16,17,19) located under the floor tile throughout the building is positive for asbestos at 2%.
**NOTE:** All non-asbestos containing flooring associated with the ACM black mastic must be considered contaminated and handled as non-friable asbestos.

These materials are considered a ***non-hazardous non-friable ACM***. It is required that a licensed asbestos abatement contractor remove these materials prior to renovation and or demolition of this structure.

### CONCLUSIONS AND REGULATIONS

Based on our survey, sampling and subsequent laboratory analysis and regulatory guidelines affecting this site, the types of ACM identified on this page require removal (in most cases) prior to demolition and/or renovation procedures to comply with local, state and federal agencies. The US EPA NESHAP (40 CFR Part 61 – November 20, 1990) requires materials containing greater than one percent asbestos be removed prior to renovation or demolition. If those materials are friable or likely to become friable due to the forces expected to act upon them during renovation or demolition, they become a regulated asbestos containing material (RACM) and require a 10-day notification to the local Air Pollution Control District prior to abatement.

Non-friable and non-regulated ACM, in most cases, may be disposed of as a Non-Hazardous waste in a landfill that accepts Asbestos Containing Materials. All friable waste containing more than 1% asbestos (RACM) must be manifested as hazardous waste for disposal purposes.

### CAL OSHA--------Construction Industry--------8CCR, 1529

Cal/OSHA worker health and safety regulations apply during any disturbance of ACM by a person while in the employ of another. This is true regardless of friability or quantity disturbed. If there is greater than 100 square feet of ACM which will be affected by the demolition, a California Licensed Contractor who is registered with Cal/OSHA for asbestos is required. The regulations regarding asbestos are found in Title 8 CCR Section 1529 and include formal notification requirements to Cal/OSHA at least 24 hours prior to removal. It is required that removal be conducted with the material kept in a wetted state to contain dust and hazardous emissions.

The construction industry standard covers employees engaged in demolition and construction, and the following related activities likely to involve asbestos exposure: removal, encapsulation, alteration, repair, maintenance, insulation, spill emergency cleanup, transportation, disposal and storage of ACM.

Demolition contractors typically require that a building owner/operator accept responsibility for removal of all ACM found during the building inspection prior to start of demolition activities.

## LIMITATIONS OF LIABILITY

Conclusions and recommendations presented in this report are qualitative judgments based on the prevailing regulations and accepted industry standards at the time of the report issuance. Leon Environmental Services provides no other guarantees, either expressed or implied. All quantities of materials listed herein are estimates for sampling purposes only and should be verified by Owner representative or an abatement contractor prior to asbestos abatement.

The nature of demolition and asbestos abatement is such that materials can be uncovered which previously were unknown to exist. Therefore, Leon Environmental Services cannot be responsible for materials not previously detected due to lack of accessibility or concealment, although every effort was made during the inspection to detect all suspect materials. If any materials other than those included herein are discovered during renovation or demolition, it must be assumed that the materials are asbestos containing and should be treated accordingly until further testing and analysis is performed.

The data interpretations and recommendations are based solely on information available to Leon Environmental Services at the time of our inspection. The customer recognizes

that site conditions or accessibility may vary from those encountered at the time of our inspection and sample collection. Varying conditions or access could result in additional information that would lead us to revise conclusions and recommendations. Leon Environmental Services will not be responsible for the interpretation or use by others of information contained within this report.

Christopher Cabral Date
Certified Asbestos Consultant
Certification No. 22-7151

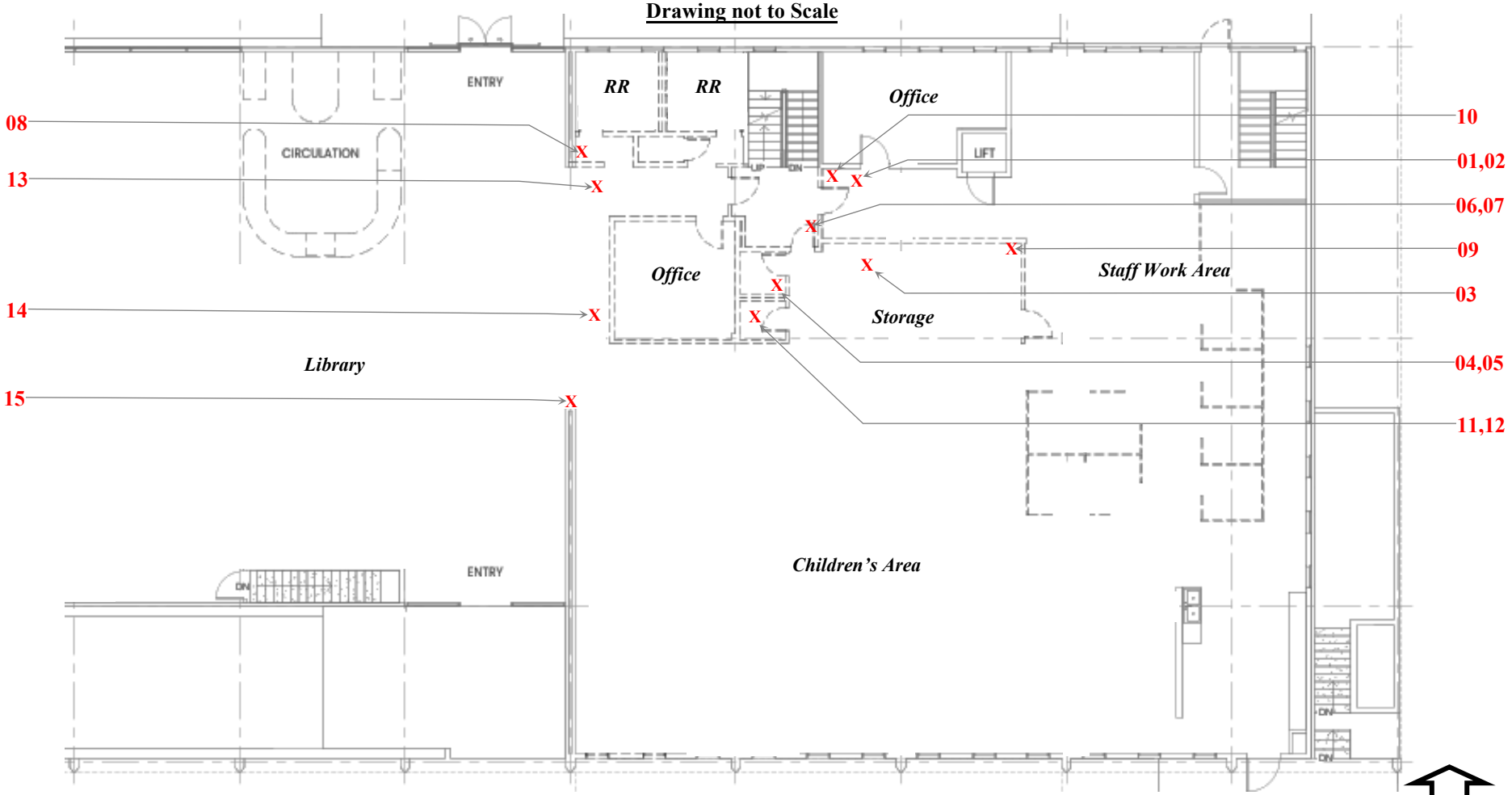
*Abbreviation Key:

*Asbestos Containing Material — ACM (equal to or greater than 0.1% by weight)*
*Vinyl Asbestos Tile – VAT*
*No Asbestos Detected--N.A.D or N.D.*
*Homogeneous—H*
*Not Sampled--NS*

# Leon Environmental Services

Richard "Danny" Leon CAC Certification No. 04-3708
Tommy Leon CAC Certification No. 05-3882

**Job B207-24 Sample Location Diagram**
**Hanford Branch Kings County Library / 401 N. Douty St, Hanford, CA**
**Megan Ulibarri / County of Kings, Public Works Dept**
**Drawing not to Scale**



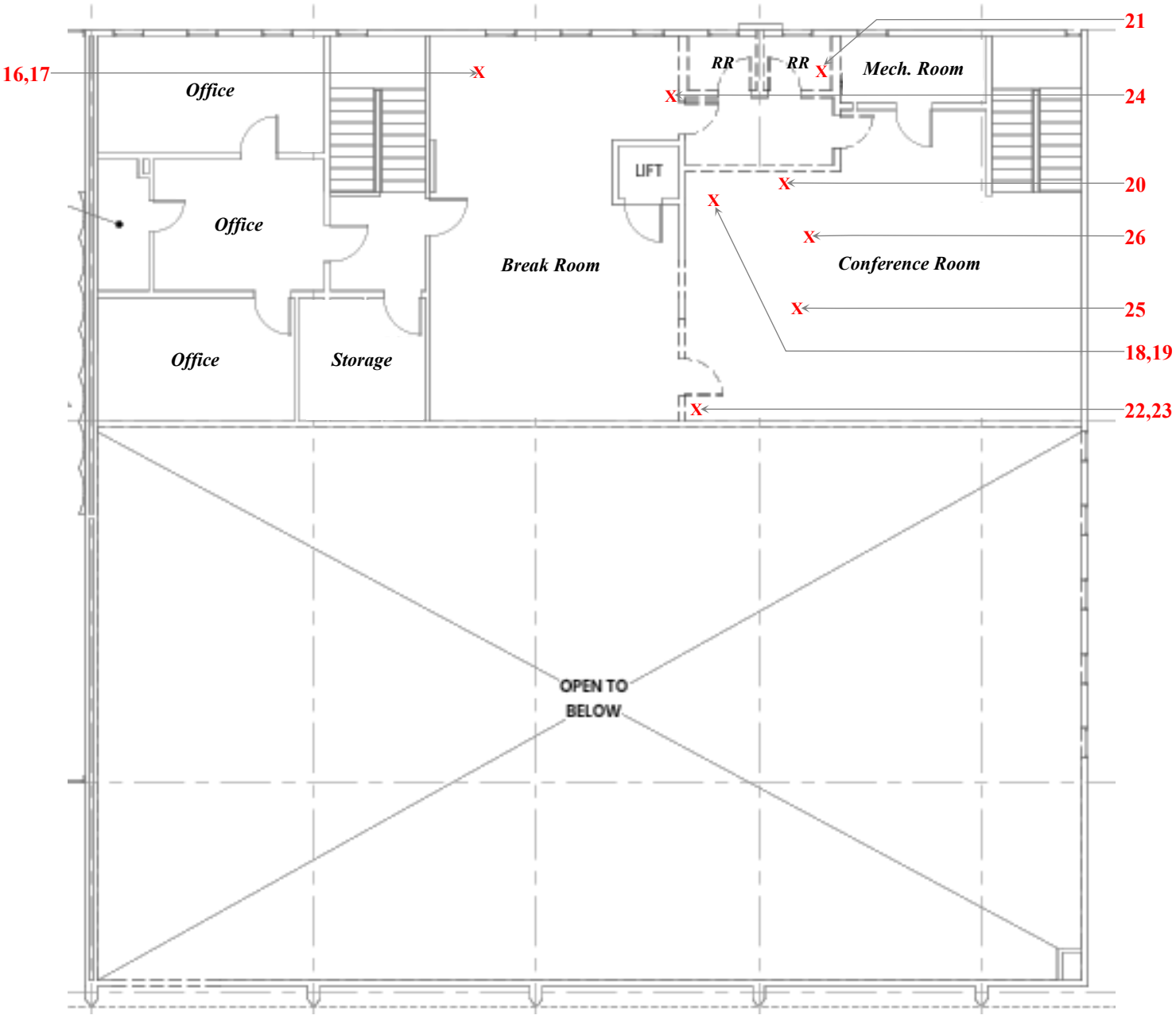

**Y = Exterior Samples**
**X = Interior Samples**
**R = Roof Samples**

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722
Phone: 559.274.9200 Fax: 559.274.9240 Email: LeonEnviro@leonenviro.com

# Leon Environmental Services

Richard "Danny" Leon CAC Certification No. 04-3708
Tommy Leon CAC Certification No. 05-3882

**Job B207-24 / Sample Location Diagram**
**Hanford Branch Kings County Library / 401 N. Douty St, Hanford, CA**
**Megan Ulibarri / County of Kings, Public Works Dept**
**Drawing not to Scale**




**Y = Exterior Samples**
**X = Interior Samples**
**R = Roof Samples**

N

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722
Phone: 559.274.9200 Fax: 559.274.9240 Email: LeonEnviro@leonenviro.com

McCall and Spero
Environmental, Inc.
Specialists in Microanalysis

1831 Williamson Court • Suite 100 • Louisville, KY 40223
Phone (502) 244-7135 • FAX (502) 244-7136
E-mail: customerservice@mselabs.com • Website: www.mselabs.com

Date: October 30, 2024

Attention: Tommy Leon
Leon Environmental Services

Subject: Analysis of bulk samples for asbestos mineral fibers by Polarized Light Microscopy (PLM) with Dispersion Staining (EPA/600/R-93/116)

RE: MSE-PO284LEO.2
Megan Ulibarri, County of Kings, Public Works Dept. - Hanford Branch Kings County Library: 401 N. Douty St; Hanford, CA Project
LEO# B207-24

Dear Mr. Leon:

McCall & Spero Environmental, Inc. has completed the analysis of the bulk samples we received from your offices on October 28, 2024. These samples represent the bulk samples from the Megan Ulibarri, County of Kings, Public Works Dept. - Hanford Branch Kings County Library: 401 N. Douty St; Hanford, CA Project.

The PLM bulk analysis was performed according to the "Method of the Determination of Asbestos in Bulk Building Materials", R. L. Perkins and B. W. Harvey (EPA/600/R-93/116).

The results for the forty-two (42) samples are summarized in the following report. Please note that for samples consisting of two or more distinct components, each component is analyzed and reported individually (EPA 40 CFR Part 61 [FRL-4821-71]).

Thank you for consulting McCall & Spero Environmental, Inc. Should you have any questions concerning these results, please contact our office.

Sincerely,

Taylor Stone

Taylor B. Stone
Senior Analyst

NVLAP®
TESTING
NVLAP LAB CODE 101895-0

# SUMMARY OF PLM BULK ANALYSIS RESULTS



Project Name: Megan Ulibarri, County of Kings, Public Works Dept. - Hanford Branch Kings County Library: 401 N. Douty St; Hanford, CA Project
McCall & Spero Environmental Project No. MSE-PO284LEO.2

| MSE # PO284LEO.2 | SAMPLE # DESCRIPTION | ASBESTOS TYPE & % | OTHER FIBROUS MATERIAL & % | % NON-FIBROUS MATERIAL | COLOR |
|---|---|---|---|---|---|
| 001 (A) | 01 (A) 9x9 Floor Tile | CH / 2% | Cellulose / 3% | 95% | Green |
| 001 (B) | 01 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 002 (A) | 02 (A) 9x9 Floor Tile | CH / 2% | Cellulose / 3% | 95% | White |
| 002 (B) | 02 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 003 | 03 Carpet Glue | ND | Cellulose / 10% | 90% | Yellow |
| 004 | 04 Grout | ND | Cellulose / 3% | 97% | Black |
| 005 | 05 Thin Set | ND | Cellulose / 3% | 97% | Blue/Gray |
| 006 (A) | 06 (A) 16/16 Floor Tile | ND | Cellulose / 3% | 97% | Brown/Blue |
| 006 (B) | 06 (B) 16x16 Floor Tile | ND | Cellulose / 3% | 97% | Brown/Blue |
| 007 | 07 Base Cove Mastic | ND | Cellulose / 7% | 93% | Beige |
| 008 (A) | 08 (A) Texture/Color Coat | ND | Cellulose / 2% | 98% | White |
| 008 (B) | 08 (B) Plaster | ND | Cellulose / 5% | 95% | White |
| 009 (A) | 09 (A) Texture/Color Coat | ND | Cellulose / 2% | 98% | Blue |
| 009 (B) | 09 (B) Plaster | ND | Cellulose / 5% | 95% | White |

# SUMMARY OF PLM BULK ANALYSIS RESULTS



| MSE # PO284LEO.2 | SAMPLE # DESCRIPTION | ASBESTOS TYPE & % | OTHER FIBROUS MATERIAL & % | % NON-FIBROUS MATERIAL | COLOR |
|---|---|---|---|---|---|
| 010 (A) | 10 (A) Texture/Color | ND | Cellulose / 2% | 98% | White |
| 010 (B) | 10 (B) Plaster | ND | Cellulose / 5% | 95% | White |
| 011 (A) | 11 (A) 1x1 Ceiling Tile | ND | Cellulose / 10% Synthetics / 40% | 50% | Orange |
| 011 (B) | 11 (B) Ceiling Tile Mastic | ND | Cellulose / 10% | 90% | Brown |
| 012 (A) | 12 (A) Texture/Color | ND | Cellulose / 2% | 98% | White |
| 012 (B) | 12 (B) Plaster | ND | Cellulose / 3% | 97% | Gray |
| 013 | 13 Spray Acoustic | ND | Cellulose / 10% Synthetics / 10% | 80% | White |
| 014 | 14 Spray Acoustic | ND | Cellulose / 10% Synthetics / 10% | 80% | White |
| 015 | 15 Spray Acoustic | ND | Cellulose / 10% Synthetics / 10% | 80% | White |
| 016 (A) | 16 (A) 9x9 Floor Tile | CH / 2% | Cellulose / 3% | 95% | Green |
| 016 (B) | 16 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 017 (A) | 17 (A) 9x9 Floor Tile | CH / 2% | Cellulose / 3% | 95% | White |
| 017 (B) | 17 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 018 | 18 Carpet Glue | ND | Cellulose / 10% | 90% | Gray |
| 019 (A) | 19 (A) Floor Tile | ND | Cellulose / 3% | 97% | Green |

# SUMMARY OF PLM BULK ANALYSIS RESULTS



| MSE # PO284LEO.2 | SAMPLE # DESCRIPTION | ASBESTOS TYPE & % | OTHER FIBROUS MATERIAL & % | % NON-FIBROUS MATERIAL | COLOR |
|---|---|---|---|---|---|
| 019 (B) | 19 (B) Mastic | ND | Cellulose / 5% | 95% | Black |
| 020 (A) | 20 (A) Base Cove Mastic | ND | Cellulose / 5% | 95% | Beige |
| 020 (B) | 20 (B) Base Cove Mastic | ND | Cellulose / 5% | 95% | Brown |
| 021 (A) | 21 (A) Texture/Color | ND | Cellulose / 2% | 98% | White |
| 021 (B) | 21 (B) Plaster | ND | Cellulose / 3% | 97% | Gray |
| 022 | 22 Wallpaper | ND | Cellulose / 10% Synthetics / 10% | 80% | Tan |
| 023 (A) | 23 (A) Texture/Color | ND | Cellulose / 2% | 98% | White |
| 023 (B) | 23 (B) Plaster | ND | Cellulose / 3% | 97% | Gray |
| 024 (A) | 24 (A) Texture/Color | ND | Cellulose / 2% | 98% | White |
| 024 (B) | 24 (B) Plaster | ND | Cellulose / 3% | 97% | Gray |
| 025 (A) | 25 (A) 1x1 Ceiling Tile | ND | Cellulose / 10% Synthetics / 40% | 50% | Yellow |
| 025 (B) | 25 (B) Ceiling Tile Mastic | ND | Cellulose / 10% | 90% | Brown |
| 026 | 26 2x4 Ceiling Panel | ND | Cellulose / 20% Glass / 30% | 50% | Gray |

# SUMMARY OF PLM BULK ANALYSIS RESULTS



NOTES:

| | | | |
|---|---|---|---|
| ND = None Detected | CH = Chrysotile | A = Amosite | AC = Actinolite |
| CR = Crocidolite | AN = Anthophyllite | TR = Tremolite | |

For samples consisting of separate components, each component is analyzed and reported separately.

Results apply only to items tested. Quantification is accurate to within ± 10%. Results from this report must not be reproduced, except in full, with the approval of McCall & Spero Environmental, Inc. This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government.

** EPA recommends that bulk materials found negative for asbestos or less than one percent asbestos by polarized light microscopy that fall into one of five dominantly nonfriable categories be reanalyzed by an additional method, such as transmission electron microscopy. (EPA Notice of Advisory, FR Vol. 59, No. 146 & Test Method EPA 600/ R-93/ 116).

Analyst: Taylor B. Stone Taylor Stone

# Leon Environmental Services

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722 Phone: 559.274.9200 Fax: 559.274.9240 Email: LeonEnviro@comcast.net

**Customer:** Megan Ulibarri **Company** County Of Kings, Public Works Dept.

**Date:** October 24, 2024 **Job No.** B207-24

**Analysis** (PLM) **Turn Around:** Rush Same Day Next Day (2-3 Day) 4-5 days

**Inspection Site :** Hanford Branch Kings County Library, 401 N. Douty St, Hanford, CA

| Sample No | Location | Material | | | Quantity |
|---|---|---|---|---|---|
| | | Color | Type | Friable | |
| 01 | Hallway - Floor | Green | 9x9 Floor Tile | | |
| | Hallway - Floor | Black | Mastic | | |
| 02 | Hallway - Floor | White | 9x9 Floor Tile | | |
| | Hallway - Floor | Black | Mastic | | |
| 03 | Storage Room - Floor | | Carpet Glue | | |
| 04 | Supply Closet - Floor | | Grout | | |
| 05 | Supply Closet - Floor | | Thin Set | | |
| 06 | Stair Hallway - Floor | Blue | 16x16 Floor Tile | | |
| | Stair Hallway - Floor | | Adhesive | | |
| 07 | Stair Hallway - Wall | Beige | Base Cove Mastic | | |
| 08 | Restroom Entry - Wall | | Texture/ Color Coat | | |
| | Restroom Entry - Wall | | Plaster | | |
| 09 | Storage Room - Wall | | Texture/ Color Coat | | |
| | Storage Room - Wall | | Plaster | | |
| 10 | Hallway - Wall | | Texture/ Color Coat | | |
| | Hallway - Wall | | Plaster | | |
| 11 | Supply Closet - Ceiling | | 1x1 Acoustic Ceiling Tile | | |
| | Supply Closet - Ceiling | Brown | Ceiling Tile Mastic | | |
| 12 | Supply Closet - Ceiling | | Texture/ Color Coat | | |
| | Supply Closet - Ceiling | | Plaster | | |

**Relinquished By** N. C. **Date** 10-24-24

**Received By** TaylorStone **Date** 10/28/24

# Leon Environmental Services

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722 Phone: 559.274.9200 Fax: 559.274.9240 Email: LeonEnviro@comcast.net

**Customer:** Megan Ulibarri **Company** County Of Kings, Public Works Dept.

**Date:** October 24, 2024 **Job No.** B207-24

**Analysis** (PLM) **Turn Around:** Rush Same Day Next Day (2-3 Day) 4-5 days

**Inspection Site :** Hanford Branch Kings County Library, 401 N. Douty St, Hanford, CA

| Sample No | Location | Material | | | Quantity |
|---|---|---|---|---|---|
| | | Color | Type | Friable | |
| 13 | Main Room - Lower Ceiling | | Spray Acoustic | | |
| 14 | Main Room - Lower Ceiling | | Spray Acoustic | | |
| 15 | Main Room - Lower Ceiling | | Spray Acoustic | | |
| 16 | 2nd Floor Break Room - Floor | Green | 9x9 Floor Tile | | |
| | 2nd Floor Break Room - Floor | Black | Mastic | | |
| 17 | 2nd Floor Break Room - Floor | White | 9x9 Floor Tile | | |
| | 2nd Floor Break Room - Floor | Black | Mastic | | |
| 18 | 2nd Floor Conference Room - Floor | | Carpet Glue | | |
| 19 | 2nd Floor Conference Room - Floor | Green | Floor Tile | | |
| | 2nd Floor Conference Room - Floor | Black | Mastic | | |
| 20 | 2nd Floor Conference Room - Wall | Beige | Base Cove Mastic | | |
| | 2nd Floor Conference Room - Wall | Brown | Base Cove Mastic | | |
| 21 | 2nd Floor Men's Restroom - Wall | | Texture/ Color Coat | | |
| | 2nd Floor Men's Restroom - Wall | | Plaster | | |
| 22 | 2nd Floor Conference Room - Wall | | Wall Paper | | |
| 23 | 2nd Floor Conference Room - Wall | | Texture/ Color Coat | | |
| | 2nd Floor Conference Room - Wall | | Plaster | | |
| 24 | 2nd Floor Break Room - Wall | | Texture/ Color Coat | | |
| | 2nd Floor Break Room - Wall | | Plaster | | |
| 25 | 2nd Floor Conference Room - Ceiling | | 1x1 Acoustic Ceiling Tile | | |

Relinquished By N. G. Date 10-24-24

Received By TaylorStone Date 10/28/24

# Leon Environmental Services

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722 Phone: 559.274.9200 Fax: 559.274.9240 Email: LeonEnviro@comcast.net

**Customer:** Megan Ulibarri **Company** County Of Kings, Public Works Dept.

**Date:** October 24, 2024 **Job No.** B207-24

**Analysis** (PLM) **Turn Around:** Rush Same Day Next Day (2-3 Day) 4-5 days

**Inspection Site :** Hanford Branch Kings County Library, 401 N. Douty St, Hanford, CA

| Sample No | Location | Material | | | Quantity |
|---|---|---|---|---|---|
| | | Color | Type | Friable | |
| | 2nd Floor Conference Room - Ceiling | Brown | Ceiling Tile Mastic | | |
| 26 | 2nd Floor Conference Room - Suspended Ceiling | | 2x4 Acoustic Ceiling Panel | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Relinquished By N. G. Date 10-24-24

Received By TaylorStone Date 10/28/24

## Sampling Site: Lemoore Branch Kings County Library
## 457 C St. Lemoore, CA
## B213-24

ASBESTOS ANALYSIS RESULTS

A total of 46 samples of suspect materials were collected by a state certified asbestos inspector from the **Lemoore Branch Kings County Library** at **457 C St, Lemoore, CA**. The sample collection areas were determined by the information given to the inspector by **Megan Ulibarri of the Kings County Public Works Department** about the impending remodel/renovation that is planned for this building. McCall and Spero Environmental, Inc., a NVLAP accredited laboratory performed a total of **68** analyses from the **46** samples collected. The chain of custody from Leon Environmental Services and the report from McCall and Spero contain a full list of all samples taken from this site.

### Samples Positive for Asbestos

| Sample | Location | Material | % Of ACM | Friable |
|---|---|---|---|---|
| 02 | Library Floor | Brown 9x9 Floor Tile | 2% | No |
| | | Black Mastic | 2% | No |
| 03 | Library Floor | Beige 9x9 Floor Tile | 2% | No |
| | | Black Mastic | 2% | No |
| 04 | Library Floor | Blue 9x9 Floor Tile | 2% | No |
| | | Black Mastic | 2% | No |
| 05 | Library Floor | Red 9x9 Floor Tile | 2% | No |
| | | Black Mastic | 2% | No |
| 06 | Southwest Office Floor | Carpet Glue/Black Mastic | 2% | No |
| 07 | Southwest Restroom Floor | Grey 12x12 Floor Tile | ND | No |
| | | Black Mastic | 2% | No |
| 08 | Janitor Closet Floor | Beige 12x12 Floor Tile | ND | No |
| | | Black Mastic | 2% | No |
| 09 | Southeast Office Floor | Carpet Glue/Black Mastic | 2% | No |
| 10 | Sheriff's Office Floor | Black Mastic | 5% | No |

**Sampling Site: Lemoore Branch Kings County Library**
**457 C St. Lemoore, CA**
**B213-24**

| | | | | |
|---|---|---|---|---|
| 12 | East Men's Restroom Floor | Beige 12x12 Floor Tile | ND | No |
| | | Black Mastic | 2% | No |

## Samples Negative for Asbestos

| Sample | Location | Material | % Of ACM | Friable |
|---|---|---|---|---|
| 01 | North Restroom Floor | Blue 12x12 Floor Tile | ND | |
| | | Adhesive | ND | |
| 11 | Northeast Lobby Closet Floor | Carpet Glue | ND | |
| 13, 14 | Southwest Office, Clerk Room Wall | Base Cove Mastic | ND | |
| 15, 16, 17, 18, 19, 20, 21 | West Restroom, Southwest Hallway, Southwest Office, Clerk Room, Interview Room, Cell Hallway, Break Room Wall | Texture/Color Coat | ND | |
| | | Plaster | ND | |
| 22 | Break Room Wall | Sheetrock Button Board | ND | |
| 23, 25, 27, 29, 31 | Southwest Office, Clerk Room, North Men's Restroom, Southeast Office, East Restroom Entry Wall | Texture/Paint | ND | |
| 24, 26, 28, 30, 32 | Southwest Office, Clerk Room, North Men's Restroom, Southeast Office, East Restroom Entry Wall | Joint Compound | ND | |
| | | Sheetrock | ND | |
| 33 | East Women's Restroom Wall | Wall Panel Adhesive | ND | |
| 34, 35, 36 | Library Ceiling, Grand Jury Room Ceiling | Spray Acoustic | ND | |
| 37, 38 | Clerk Room, Southeast Office Suspended Ceiling | 2x4 Acoustic Ceiling Panel | ND | |
| 39 | Sheriff's Office Ceiling (Bottom Layer) | 1x1 Acoustic Ceiling Tile | ND | |
| | | Brown Mastic | ND | |

## Sampling Site: Lemoore Branch Kings County Library
## 457 C St. Lemoore, CA
## B213-24

| | | | | |
|---|---|---|---|---|
| 40 | Sheriff's Office Ceiling (Top Layer) | 1x1 Acoustic Ceiling Tile | ND | |
| 41 | Southwest Hallway Ceiling | 1x1 Acoustic Ceiling Tile | ND | |
| | | Vapor Barrier | ND | |
| 42, 43 | Roof, North and South Areas | Roof Core | ND | |
| 44 | Roof Jack | Roof Mastic | ND | |
| 45 | Roof Vent | Roof Sealant | ND | |
| 46 | Roof AC Unit Duct | Tape | ND | |

* Determined after composite sampling with associated sheetrock
NS – Not Sampled

### COMMENTS AND RECOMMENDATIONS

***Non-Friable Asbestos***

***The 9x9 Floor Tile (All Colors)*** (samples 02, 03, 04, 05) located on the floor of the library is positive for asbestos at 2%.
***The Black Mastic*** (samples 02, 03, 04, 05, 06, 07, 08, 09, 10, 12) located under the flooring throughout the building is positive for asbestos at 2-5%.
**NOTE:** All non-asbestos containing flooring associated with the ACM black mastic must be considered contaminated and handled as non-friable asbestos.

These materials are considered a ***non-hazardous non-friable ACM***. It is required that a licensed asbestos abatement contractor remove these materials prior to renovation and or demolition of this structure.

### CONCLUSIONS AND REGULATIONS

Based on our survey, sampling and subsequent laboratory analysis and regulatory guidelines affecting this site, the types of ACM identified on this page require removal (in most cases) prior to demolition and/or renovation procedures to comply with local, state and federal agencies. The US EPA NESHAP (40 CFR Part 61 – November 20, 1990) requires materials containing greater than one percent asbestos be removed prior to renovation or demolition. If those materials are friable or likely to become friable due to the forces expected to act upon them during renovation or demolition, they become a regulated asbestos containing material (RACM) and require a 10-day notification to the local Air Pollution Control District prior to abatement.

Non-friable and non-regulated ACM, in most cases, may be disposed of as a Non-Hazardous waste in a landfill that accepts Asbestos Containing Materials. All friable waste containing more than 1% asbestos (RACM) must be manifested as hazardous waste for disposal purposes.

**CAL OSHA--------Construction Industry--------8CCR, 1529**

Cal/OSHA worker health and safety regulations apply during any disturbance of ACM by a person while in the employ of another. This is true regardless of friability or quantity disturbed. If there is greater than 100 square feet of ACM which will be affected by the demolition, a California Licensed Contractor who is registered with Cal/OSHA for asbestos is required. The regulations regarding asbestos are found in Title 8 CCR Section 1529, and also include formal notification requirements to Cal/OSHA at least 24 hours prior to removal. It is required that removal be conducted with the material kept in a wetted state to contain dust and hazardous emissions.

The construction industry standard covers employees engaged in demolition and construction, and the following related activities likely to involve asbestos exposure: removal, encapsulation, alteration, repair, maintenance, insulation, spill emergency cleanup, transportation, disposal and storage of ACM.

Demolition contractors typically require that a building owner/operator accept responsibility for removal of all ACM found during the building inspection prior to start of demolition activities.

## LIMITATIONS OF LIABILITY

Conclusions and recommendations presented in this report are qualitative judgments based on the prevailing regulations and accepted industry standards at the time of the report issuance. Leon Environmental Services provides no other guarantees, either expressed or implied. All quantities of materials listed herein are estimates for sampling purposes only, and should be verified by Owner representative or an abatement contractor prior to asbestos abatement.

The nature of demolition and asbestos abatement is such that materials can be uncovered which previously were unknown to exist. Therefore, Leon Environmental Services cannot be responsible for materials not previously detected due to lack of accessibility or concealment, although every effort was made during the inspection to detect all suspect materials. If any materials other than those included herein are discovered during renovation or demolition, it must be assumed that the materials are asbestos containing, and should be treated accordingly until further testing and analysis is performed.

The data interpretations and recommendations are based solely on information available to Leon Environmental Services at the time of our inspection. The customer recognizes that site conditions or accessibility may vary, from those encountered at the time of our inspection and sample collection. Varying conditions or access could result in additional

information that would lead us to revise conclusions and recommendations. Leon Environmental Services will not be responsible for the interpretation or use by others of information contained within this report.

---

Christopher Cabral Date
Certified Asbestos Consultant
Certification No. 22-7151

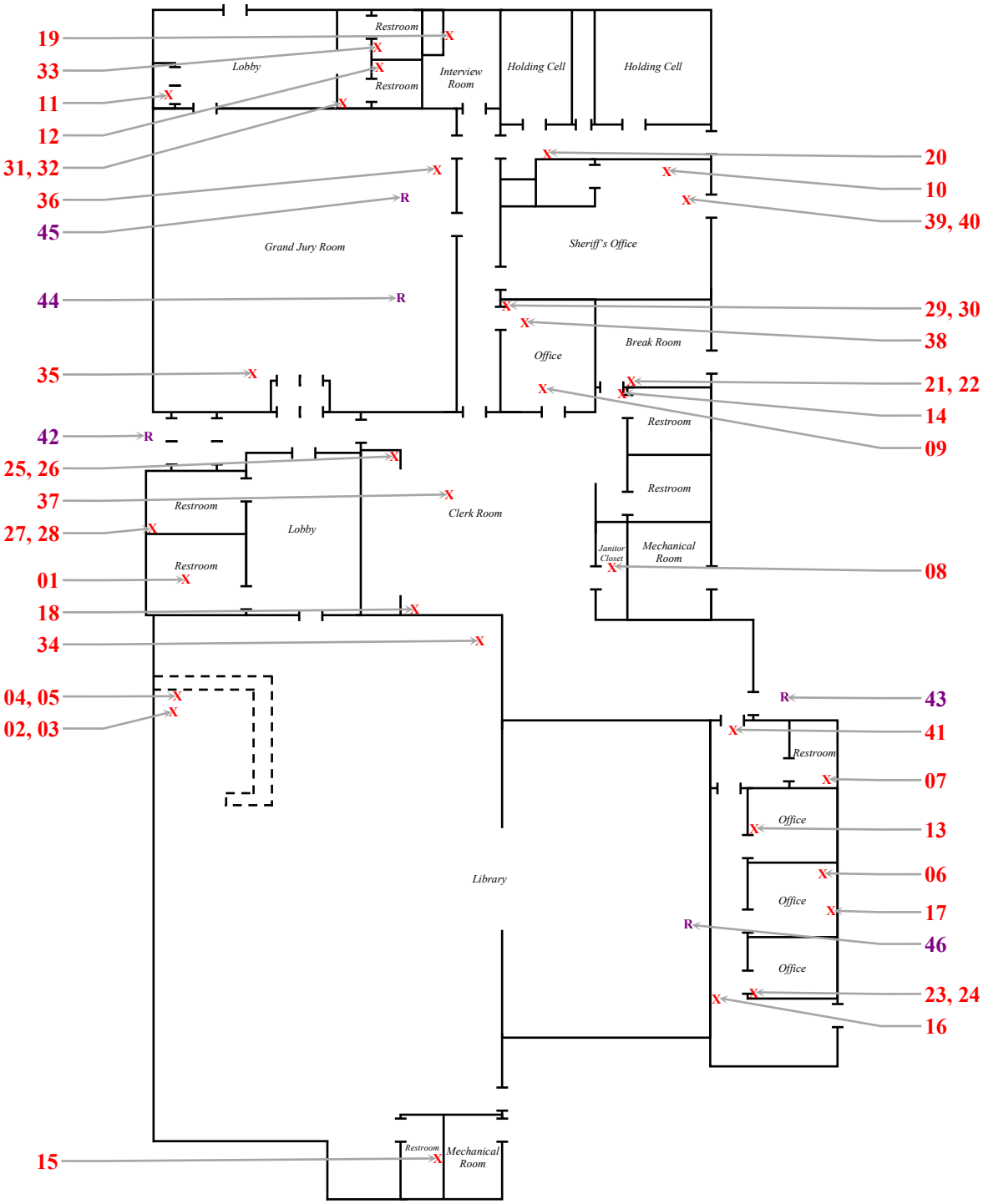
*Abbreviation Key:

*Asbestos Containing Material — ACM (equal to or greater than 0.1% by weight)*
*Vinyl Asbestos Tile – VAT*
*No Asbestos Detected--N.A.D or N.D.*
*Homogeneous—H*
*Not Sampled--NS*

# Leon Environmental Services

Richard "Danny" Leon CAC Certification No. 04-3708
Tommy Leon CAC Certification No. 05-3882

**Job B213-24 Sample Location Diagram**
**Lemoore Branch Kings County Library / 457 C St, Lemoore, CA**
**Megan Ulibarri / County of Kings, Public Works Dept.**
**Drawing Not to Scale**




**X = Interior Samples**
**Y = Exterior Samples**
**R = Roof Samples**

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722
Phone: 559.274.9200 Fax: 559.274.9240 Email: LeonEnviro@comcast.net

McCall and Spero
Environmental, Inc.
Specialists in Microanalysis

1831 Williamson Court • Suite 100 • Louisville, KY 40223
Phone (502) 244-7135 • FAX (502) 244-7136
E-mail: customerservice@mselabs.com • Website: www.mselabs.com

Date: November 11, 2024

Attention: Tommy Leon
Leon Environmental Services

Subject: Analysis of bulk samples for asbestos mineral fibers by Polarized Light Microscopy (PLM) with Dispersion Staining (EPA/600/R-93/116)

RE: MSE-PN74LEO.3
Megan Ulivarri; County of Kings, Public Works Dept. - Lemoore Branch Kings County Library: 457 C Street; Lemoore, CA Project
LEO# B213-24

Dear Mr. Leon:

McCall & Spero Environmental, Inc. has completed the analysis of the bulk samples we received from your offices on November 7, 2024. These samples represent the bulk samples from the Megan Ulivarri; County of Kings, Public Works Dept. - Lemoore Branch Kings County Library: 457 C Street; Lemoore, CA Project.

The PLM bulk analysis was performed according to the "Method of the Determination of Asbestos in Bulk Building Materials", R. L. Perkins and B. W. Harvey (EPA/600/R-93/116).

The results for the sixty-eight (68) samples are summarized in the following report. Please note that for samples consisting of two or more distinct components, each component is analyzed and reported individually (EPA 40 CFR Part 61 [FRL-4821-71]).

Thank you for consulting McCall & Spero Environmental, Inc. Should you have any questions concerning these results, please contact our office.

Sincerely,

Taylor Stone

Taylor B. Stone
Senior Analyst

NVLAP®
TESTING
NVLAP LAB CODE 101895-0

# SUMMARY OF PLM BULK ANALYSIS RESULTS



Project Name: Megan Ulivarri; County of Kings, Public Works Dept. - Lemoore Branch Kings County Library: 457 C Street; Lemoore, CA Project
McCall & Spero Environmental Project No. MSE-PN74LEO.3

| MSE # PN74LEO.3 | SAMPLE # DESCRIPTION | ASBESTOS TYPE & % | OTHER FIBROUS MATERIAL & % | % NON-FIBROUS MATERIAL | COLOR |
|---|---|---|---|---|---|
| 001 (A) | 01 (A) 12x12 Floor Tile | ND | Cellulose / 2% | 98% | Blue |
| 001 (B) | 01 (B) Adhesive | ND | Cellulose / 5% | 95% | Brown |
| 002 (A) | 02 (A) 9x9 Floor Tile | CH / 2% | Cellulose / 3% | 95% | Brown |
| 002 (B) | 02 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 003 (A) | 03 (A) 9x9 Floor Tile | CH / 2% | Cellulose / 3% | 95% | Yellow |
| 003 (B) | 03 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 004 (A) | 04 (A) 9x9 Floor Tile | CH / 2% | Cellulose / 3% | 95% | Blue |
| 004 (B) | 04 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 005 (A) | 05 (A) 9x9 Floor Tile | CH / 2% | Cellulose / 3% | 95% | Red |
| 005 (B) | 05 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 006 | 06 Carpet Glue/Mastic | CH / 2% | Cellulose / 10% | 88% | Yellow/ Black |
| 007 (A) | 07 (A) 12x12 Floor Tile | ND | Cellulose / 2% | 98% | Gray |
| 007 (B) | 07 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 008 (A) | 08 (A) 12x12 Floor Tile | ND | Cellulose / 2% | 98% | Beige |

# SUMMARY OF PLM BULK ANALYSIS RESULTS



| MSE # PN74LEO.3 | SAMPLE # DESCRIPTION | ASBESTOS TYPE & % | OTHER FIBROUS MATERIAL & % | % NON-FIBROUS MATERIAL | COLOR |
|---|---|---|---|---|---|
| 008 (B) | 08 (B) Mastic | CH / 2% | Cellulose / 5% | 93% | Black |
| 009 | 09 Carpet Glue/Mastic | CH / 2% | Cellulose / 10% | 88% | Yellow/ Black |
| 010 | 10 Mastic | CH / 5% | Cellulose / 10% | 85% | Black |
| 011 | 11 Carpet Glue | ND | Cellulose / 10% | 90% | Yellow |
| 012 (A) | 12 (A) 12x12 Floor Tile | ND | Cellulose / 2% | 98% | Beige |
| 012 (B) | 12 (B) Mastic | CH / 2% | Cellulose / 3% | 95% | Black |
| 013 | 13 Base Cove Mastic | ND | Cellulose / 5% | 95% | Yellow |
| 014 | 14 Base Cove Mastic | ND | Cellulose / 10% | 90% | Brown |
| 015 (A) | 15 (A) Texture / Color Coat | ND | Cellulose / 2% | 98% | White |
| 015 (B) | 15 (B) Plaster | ND | Cellulose / 5% | 95% | White |
| 016 (A) | 16 (A) Texture / Color Coat | ND | Cellulose / 2% | 98% | White |
| 016 (B) | 16 (B) Plaster | ND | Cellulose / 5% | 95% | White |
| 017 (A) | 17 (A) Texture / Color Coat | ND | Cellulose / 2% | 98% | White |
| 017 (B) | 17 (B) Plaster | ND | Cellulose / 5% | 95% | White |
| 018 (A) | 18 (A) Texture / Color Coat | ND | Cellulose / 2% | 98% | White |

# SUMMARY OF PLM BULK ANALYSIS RESULTS



| MSE # PN74LEO.3 | SAMPLE # DESCRIPTION | ASBESTOS TYPE & % | OTHER FIBROUS MATERIAL & % | % NON-FIBROUS MATERIAL | COLOR |
|---|---|---|---|---|---|
| 018 (B) | 18 (B) Plaster | ND | Cellulose / 5% | 95% | White |
| 019 (A) | 19 (A) Texture / Color Coat | ND | Cellulose / 2% | 98% | White |
| 019 (B) | 19 (B) Plaster | ND | Cellulose / 5% | 95% | White |
| 020 (A) | 20 (A) Texture / Color Coat | ND | Cellulose / 2% | 98% | Tan |
| 020 (B) | 20 (B) Plaster | ND | Cellulose / 3% | 97% | Gray |
| 021 (A) | 21 (A) Texture / Color Coat | ND | Cellulose / 2% | 98% | White |
| 021 (B) | 21 (B) Plaster | ND | Cellulose / 5% | 95% | White |
| 022 | 22 Sheetrock Button Board | ND | Cellulose / 10% | 90% | White |
| 023 | 23 Texture / Paint | ND | Cellulose / 2% | 98% | White |
| 024 (A) | 24 (A) Joint Compound | ND | Cellulose / 5% | 95% | White |
| 024 (B) | 24 (B) Sheetrock | ND | Cellulose / 10% | 90% | White |
| 025 | 25 Texture / Paint | ND | Cellulose / 2% | 98% | Tan |
| 026 (A) | 26 (A) Joint Compound | ND | Cellulose / 5% | 95% | White |
| 026 (B) | 26 (B) Sheetrock | ND | Cellulose / 10% | 90% | White |
| 027 | 27 Texture / Paint | ND | Cellulose / 2% | 98% | White |

# SUMMARY OF PLM BULK ANALYSIS RESULTS



| MSE # PN74LEO.3 | SAMPLE # DESCRIPTION | ASBESTOS TYPE & % | OTHER FIBROUS MATERIAL & % | % NON-FIBROUS MATERIAL | COLOR |
|---|---|---|---|---|---|
| 028 (A) | 28 (A) Joint Compound | ND | Cellulose / 5% | 95% | White |
| 028 (B) | 28 (B) Sheetrock | ND | Cellulose / 10% | 90% | White |
| 029 | 29 Texture / Paint | ND | Cellulose / 2% | 98% | Tan |
| 030 (A) | 30 (A) Joint Compound | ND | Cellulose / 5% | 95% | White |
| 030 (B) | 30 (B) Sheetrock | ND | Cellulose / 10% | 90% | White |
| 031 | 31 Texture / Paint | ND | Cellulose / 2% | 98% | Tan |
| 032 (A) | 32 (A) Joint Compound | ND | Cellulose / 5% | 95% | White |
| 032 (B) | 32 (B) Sheetrock | ND | Cellulose / 10% | 90% | White |
| 033 | 33 Wall Panel Adhesive | ND | Cellulose / 10% | 90% | Yellow |
| 034 | 34 Spray Acoustic | ND | Cellulose / 10% | 90% | White |
| 035 | 35 Spray Acoustic | ND | Cellulose / 10% | 90% | White |
| 036 | 36 Spray Acoustic | ND | Cellulose / 10% | 90% | White |
| 037 | 37 2x4 Ceiling Panel | ND | Cellulose / 20% Glass / 30% | 50% | Tan |
| 038 | 38 2x4 Ceiling Panel | ND | Cellulose / 15% | 85% | White |
| 039 (A) | 39 (A) 1x1 Ceiling Tile | ND | Cellulose / 20% Glass / 30% | 50% | Gray |

# SUMMARY OF PLM BULK ANALYSIS RESULTS



| MSE # PN74LEO.3 | SAMPLE # DESCRIPTION | ASBESTOS TYPE & % | OTHER FIBROUS MATERIAL & % | % NON-FIBROUS MATERIAL | COLOR |
|---|---|---|---|---|---|
| 039 (B) | 39 (B) Mastic | ND | Cellulose / 10% | 90% | Brown |
| 040 | 40 1x1 Ceiling Tile | ND | Cellulose / 10% Synthetics / 40% | 50% | Yellow |
| 041 (A) | 41 (A) 1x1 Ceiling Tile | ND | Cellulose / 10% Synthetics / 40% | 50% | Yellow |
| 041 (B) | 41 (B) Vapor Barrier | ND | Cellulose / 10% Synthetics / 20% | 70% | Brown/ Black |
| 042 | 42 Roof Core | ND | Cellulose / 15% Glass / 15% | 70% | White/ Black |
| 043 | 43 Roof Core | ND | Cellulose / 15% Glass / 15% | 70% | Black |
| 044 | 44 Roof Mastic | ND | Cellulose / 10% | 90% | Black |
| 045 | 45 Roof Sealant | ND | Cellulose / 5% | 95% | Tan/White |
| 046 | 46 Tape | ND | Cellulose / 10% Synthetics / 10% | 80% | White |

# SUMMARY OF PLM BULK ANALYSIS RESULTS



NOTES:

| | | | |
|---|---|---|---|
| ND = None Detected | CH = Chrysotile | A = Amosite | AC = Actinolite |
| CR = Crocidolite | AN = Anthophyllite | TR = Tremolite | |

For samples consisting of separate components, each component is analyzed and reported separately.

Results apply only to items tested. Quantification is accurate to within ± 10%. Results from this report must not be reproduced, except in full, with the approval of McCall & Spero Environmental, Inc. This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government.

** EPA recommends that bulk materials found negative for asbestos or less than one percent asbestos by polarized light microscopy that fall into one of five dominantly nonfriable categories be reanalyzed by an additional method, such as transmission electron microscopy. (EPA Notice of Advisory, FR Vol. 59, No. 146 & Test Method EPA 600/ R-93/ 116).

Analyst: Taylor B. Stone Taylor Stone

# Leon Environmental Services

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722 Phone: (559) 274-9200 Fax: (559) 274-9240 Email: Leonenviro@comcast.net

**Customer:** Megan Ulibarri **Company:** County of Kings, Public Works Dept.

**Date:** November 5, 2024 **Job No:** B213-24

**Analysis:** PLM **Turn Around:** RUSH Same Day Next Day (2-3 Days) 4-5 Days

**Inspection Site:** Lemoore Branch Kings County Library, 457 C Street, Lemoore, CA

| Sample No. | Location | Material | | Quantity |
|---|---|---|---|---|
| | | Color | Type | |
| 01 | North Restroom Floor | Blue | 12x12 Floor Tile | |
| | North Restroom Floor | | Adhesive | |
| 02 | Library Floor | Brown | 9x9 Floor Tile | |
| | Library Floor | Black | Mastic | |
| 03 | Library Floor | Beige | 9x9 Floor Tile | |
| | Library Floor | Black | Mastic | |
| 04 | Library Floor | Blue | 9x9 Floor Tile | |
| | Library Floor | Black | Mastic | |
| 05 | Library Floor | Red | 9x9 Floor Tile | |
| | Library Floor | Black | Mastic | |
| 06 | Southwest Office Floor | | Carpet Glue/Black Mastic | |
| 07 | Southwest Restroom Floor | Grey | 12x12 Floor Tile | |
| | Southwest Restroom Floor | Black | Mastic | |
| 08 | Janitor Closet Floor | Beige | 12x12 Floor Tile | |
| | Janitor Closet Floor | Black | Mastic | |
| 09 | Southeast Office Floor | | Carpet Glue/Black Mastic | |
| 10 | Sheriff's Office Wall | Black | Mastic | |
| 11 | Northeast Lobby Closet Floor | | Carpet Glue | |
| 12 | East Men's Restroom Floor | Beige | 12x12 Floor Tile | |
| | East Men's Restroom Floor | Black | Mastic | |
| 13 | Southwest Office Wall | | Base Cove Mastic | |

**Relinquished By:** Cliff Ch **Date:** 11-6-24 **Received By:** Taylor Stone **Date:** 111724

# Leon Environmental Services

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722 Phone: (559) 274-9200 Fax: (559) 274-9240 Email: Leonenviro@comcast.net

**Customer:** Megan Ulibarri **Company:** County of Kings, Public Works Dept.

**Date:** November 5, 2024 **Job No:** B213-24

**Analysis:** PLM **Turn Around:** RUSH Same Day Next Day (2-3 Days) 4-5 Days

**Inspection Site:** Lemoore Branch Kings County Library, 457 C Street, Lemoore, CA

| Sample No. | Location | Material | | Quantity |
|---|---|---|---|---|
| | | Color | Type | |
| 14 | Clerk Room Wall | | Base Cove Mastic | |
| 15 | West Restroom Wall | | Texture/Color Coat | |
| | West Restroom Wall | | Plaster | |
| 16 | Southwest Hallway Wall | | Texture/Color Coat | |
| | Southwest Hallway Wall | | Plaster | |
| 17 | Southwest Office Wall | | Texture/Color Coat | |
| | Southwest Office Wall | | Plaster | |
| 18 | Clerk Room Wall | | Texture/Color Coat | |
| | Clerk Room Wall | | Plaster | |
| 19 | Interview Room Wall | | Texture/Color Coat | |
| | Interview Room Wall | | Plaster | |
| 20 | Cell Hallway Wall | | Texture/Color Coat | |
| | Cell Hallway Wall | | Plaster | |
| 21 | Break Room Wall | | Texture/Color Coat | |
| | Break Room Wall | | Plaster | |
| 22 | Break Room Wall | | Sheetrock Button Board | |
| 23 | Southwest Office Wall | | Texture/Paint | |
| 24 | Southwest Office Wall | | Joint Compound | |
| | Southwest Office Wall | | Sheetrock | |
| 25 | Clerk Room Wall | | Texture/Paint | |
| 26 | Clerk Room Wall | | Joint Compound | |

**Relinquished By:** [signature] **Date:** 11-6-24

**Received By:** Taylor Stone **Date:** 11/7/24

# Leon Environmental Services

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722 Phone: (559) 274-9200 Fax: (559) 274-9240 Email: Leonenviro@comcast.net

**Customer:** Megan Ulibarri **Company:** County of Kings, Public Works Dept.

**Date:** November 5, 2024 **Job No:** B213-24

**Analysis:** PLM **Turn Around:** RUSH Same Day Next Day ~~2-3 Days~~ 4-5 Days

**Inspection Site:** Lemoore Branch Kings County Library, 457 C Street, Lemoore, CA

| Sample No. | Location | Material | | Quantity |
|---|---|---|---|---|
| | | Color | Type | |
| 26 | Clerk Room Wall | | Sheetrock | |
| 27 | North Men's Restroom Wall | | Texture/Paint | |
| 28 | North Men's Restroom Wall | | Joint Compound | |
| | North Men's Restroom Wall | | Sheetrock | |
| 29 | Southeast Office Wall | | Texture/Paint | |
| 30 | Southeast Office Wall | | Joint Compound | |
| | Southeast Office Wall | | Sheetrock | |
| 31 | East Restroom Entry Wall | | Texture/Paint | |
| 32 | East Restroom Entry Wall | | Joint Compound | |
| | East Restroom Entry Wall | | Sheetrock | |
| 33 | East Women's Restroom Wall | | Wall Panel Adhesive | |
| 34 | Library Ceiling | | Spray Acoustic | |
| 35 | Grand Jury Room Ceiling | | Spray Acoustic | |
| 36 | Grand Jury Room Ceiling | | Spray Acoustic | |
| 37 | Clerk Room Suspended Ceiling | | 2x4 Acoustic Ceiling Panel | |
| 38 | Southeast Office Suspended Ceiling | | 2x4 Sheetrock Ceiling Panel | |
| 39 | Sheriff's Office Ceiling (Bottom Layer) | | 1x1 Acoustic Ceiling Tile | |
| | Sheriff's Office Ceiling (Bottom Layer) | Brown | Mastic | |
| 40 | Sheriff's Office Ceiling (Top Layer) | | 1x1 Acoustic Ceiling Tile | |
| 41 | Southwest Hallway Ceiling | | 1x1 Acoustic Ceiling Tile | |
| | Southwest Hallway Ceiling | | Vapor Barrier | |

**Relinquished By:** [signature] **Date:** 11-6-24 **Received By:** TaylorStone **Date:** 11/7/24

# Leon Environmental Services

4545 N. Brawley Ave., Suite 104, Fresno, CA 93722 Phone: (559) 274-9200 Fax: (559) 274-9240 Email: Leonenviro@comcast.net

**Customer:** Megan Ulibarri **Company:** County of Kings, Public Works Dept.

**Date:** November 5, 2024 **Job No:** B213-24

**Analysis:** PLM **Turn Around:** RUSH Same Day Next Day 2-3 Days 4-5 Days

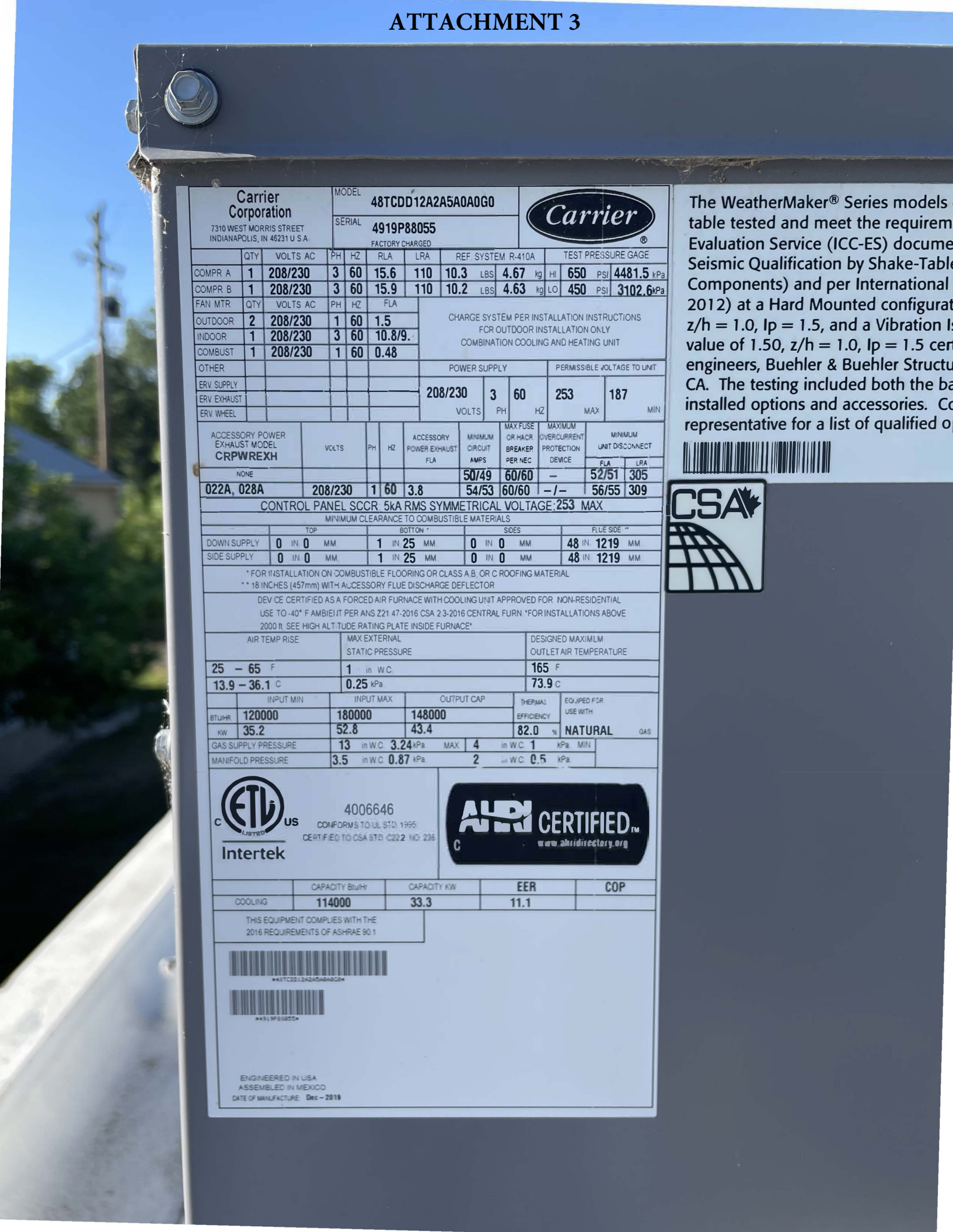
**Inspection Site:** Lemoore Branch Kings County Library, 457 C Street, Lemoore, CA

| Sample No. | Location | Material | | Quantity |
|---|---|---|---|---|
| | | Color | Type | |
| 42 | Roof, North Area | | Roof Core | |
| 43 | Roof, South Area | | Roof Core | |
| 44 | Roof Jack | | Roof Mastic | |
| 45 | Roof Vent | | Roof Sealant | |
| 46 | Roof, AC Unit Duct | | Tape | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Relinquished By:** [signature] **Date:** 11-6-24

**Received By:** Taylor Stone **Date:** 111724

# ATTACHMENT 3



Carrier Corporation
7310 WEST MORRIS STREET
INDIANAPOLIS, IN 46231 U.S.A.

MODEL 48TCDD12A2A5A0A0G0
SERIAL 4919P88055
FACTORY CHARGED

Carrier®

| | QTY | VOLTS AC | PH | HZ | RLA | LRA | REF. SYSTEM R-410A | TEST PRESSURE GAGE |
|---|---|---|---|---|---|---|---|---|
| COMPR A | 1 | 208/230 | 3 | 60 | 15.6 | 110 | 10.3 LBS 4.67 kg | HI 650 PSI 4481.5 kPa |
| COMPR B | 1 | 208/230 | 3 | 60 | 15.9 | 110 | 10.2 LBS 4.63 kg | LO 450 PSI 3102.6 kPa |

| FAN MTR | QTY | VOLTS AC | PH | HZ | FLA |
|---|---|---|---|---|---|
| OUTDOOR | 2 | 208/230 | 1 | 60 | 1.5 |
| INDOOR | 1 | 208/230 | 3 | 60 | 10.8/9. |
| COMBUST | 1 | 208/230 | 1 | 60 | 0.48 |

CHARGE SYSTEM PER INSTALLATION INSTRUCTIONS
FOR OUTDOOR INSTALLATION ONLY
COMBINATION COOLING AND HEATING UNIT

| OTHER | | | | | |
|---|---|---|---|---|---|
| ERV SUPPLY | | | | | |
| ERV EXHAUST | | | | | |
| ERV WHEEL | | | | | |

| POWER SUPPLY | | | PERMISSIBLE VOLTAGE TO UNIT | |
|---|---|---|---|---|
| 208/230 VOLTS | 3 PH | 60 HZ | 253 MAX | 187 MIN |

| ACCESSORY POWER EXHAUST MODEL CRPWREXH | VOLTS | PH | HZ | ACCESSORY POWER EXHAUST FLA | MINIMUM CIRCUIT AMPS | MAX FUSE OR HACR BREAKER PER NEC | MAXIMUM OVERCURRENT PROTECTION DEVICE | MINIMUM UNIT DISCONNECT FLA | MINIMUM UNIT DISCONNECT LRA |
|---|---|---|---|---|---|---|---|---|---|
| NONE | | | | | 50/49 | 60/60 | – | 52/51 | 305 |
| 022A, 028A | 208/230 | 1 | 60 | 3.8 | 54/53 | 60/60 | –/– | 56/55 | 309 |

CONTROL PANEL SCCR: 5kA RMS SYMMETRICAL VOLTAGE: 253 MAX

MINIMUM CLEARANCE TO COMBUSTIBLE MATERIALS

| | TOP | BOTTON * | SIDES | FLUE SIDE ** |
|---|---|---|---|---|
| DOWN SUPPLY | 0 IN 0 MM | 1 IN 25 MM | 0 IN 0 MM | 48 IN 1219 MM |
| SIDE SUPPLY | 0 IN 0 MM | 1 IN 25 MM | 0 IN 0 MM | 48 IN 1219 MM |

* FOR INSTALLATION ON COMBUSTIBLE FLOORING OR CLASS A B OR C ROOFING MATERIAL
** 18 INCHES (457mm) WITH ACCESSORY FLUE DISCHARGE DEFLECTOR

DEVICE CERTIFIED AS A FORCED AIR FURNACE WITH COOLING UNIT APPROVED FOR NON-RESIDENTIAL USE TO -40° F AMBIENT PER ANSI Z21.47-2016 CSA 2.3-2016 CENTRAL FURN. *FOR INSTALLATIONS ABOVE 2000 ft. SEE HIGH ALTITUDE RATING PLATE INSIDE FURNACE*

| AIR TEMP RISE | MAX EXTERNAL STATIC PRESSURE | DESIGNED MAXIMUM OUTLET AIR TEMPERATURE |
|---|---|---|
| 25 – 65 F | 1 in W.C. | 165 F |
| 13.9 – 36.1 C | 0.25 kPa | 73.9 C |

| | INPUT MIN | INPUT MAX | OUTPUT CAP | THERMAL EFFICIENCY | EQUIPED FOR USE WITH |
|---|---|---|---|---|---|
| BTU/HR | 120000 | 180000 | 148000 | 82.0 % | NATURAL GAS |
| KW | 35.2 | 52.8 | 43.4 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| GAS SUPPLY PRESSURE | 13 in W.C. | 3.24 kPa | MAX | 4 in W.C. | 1 kPa | MIN |
| MANIFOLD PRESSURE | 3.5 in W.C. | 0.87 kPa | | 2 in W.C. | 0.5 kPa | |

ETL LISTED c US
Intertek
4006646
CONFORMS TO UL STD 1995
CERTIFIED TO CSA STD C22.2 NO. 236

AHRI CERTIFIED™ c
www.ahridirectory.org

| | CAPACITY Btu/Hr | CAPACITY KW | EER | COP |
|---|---|---|---|---|
| COOLING | 114000 | 33.3 | 11.1 | |

THIS EQUIPMENT COMPLIES WITH THE 2016 REQUIREMENTS OF ASHRAE 90.1

*48TCDD12A2A5A0A0G0*

*4919P88055*

ENGINEERED IN USA
ASSEMBLED IN MEXICO
DATE OF MANUFACTURE Dec – 2019

The WeatherMaker® Series models
table tested and meet the requirem
Evaluation Service (ICC-ES) docume
Seismic Qualification by Shake-Table
Components) and per International
2012) at a Hard Mounted configurat
z/h = 1.0, Ip = 1.5, and a Vibration I
value of 1.50, z/h = 1.0, Ip = 1.5 cer
engineers, Buehler & Buehler Structu
CA. The testing included both the ba
installed options and accessories. Co
representative for a list of qualified o

CSA

**SECTION 23 09 00**
**BUILDING AUTOMATION SYSTEM (BAS) CONTROLS**

## PART 1 GENERAL

### 1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

### 1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include but not necessarily be limited to the following:

1. Provide new direct digital Building Automation System (BAS) for the new building with all hardware, software, controller, devices, sensors, conduit, wiring, and labor as required to provide complete and operational systems.
2. Provide control components and sequences of operation to meet or exceed the minimum requirements of the local applicable energy code and building codes.

B. General Requirements

1. The work includes designing, providing and installing a complete and fully operable building automation system as described in this Section of the Specification and as shown on the contract construction drawings and shall be in accordance with rules, regulations and standards as required by the authorities having jurisdiction. Any alternations to the quantity or location of the control panels shall be coordinated with the Electrical Contractor and General Contractor prior to bidding. Any BAS changes after bidding must be coordinated with Electrical Contractor and General Contractor at no additional cost to Owner.
2. Submit shop drawings of the entire control system components fully coordinated with major equipment suppliers' requirements. Provide proposed programming logic sequences of control functions on each system.
3. Installation of control components other than valves, dampers and sensing wells as required for a complete and workable system.
4. This Contractor shall furnish, install and coordinate the interlock and control wiring as specified and/or required for a complete and workable control system.
5. Control dampers are specified and furnished in Section 233113 of these specifications. Provide damper actuators, wiring and conduit as required to operate all dampers as shown.
6. Upon completion of the installation, data entry and programming, provide complete validation and adjustment of specified control system through period of testing and Owner's acceptance. The control contractor shall perform a point-to-point check out of all newly installed points to verify point existence, proper end to end connection and correct SI units with the Owners Representative.
7. The entire program and sequence of operation with the final points list shall be verified by the Control Contractor, the Owner's Representative, and signed by both parties. A copy of the final program, sequence of operation, and points list shall be submitted to the Engineer for approval and inclusion with the operation and maintenance manuals.
8. Owner training on operation of the control system.
9. One-year warranty on workmanship and materials.

10. Interlocking of electrical systems and motors as shown on Drawings, except where specifically shown on electrical drawings.
11. All parameters identified in the controls sequence shall be adjustable at the front-end by the end user.
12. Contractor shall establish, tune, and coordinate all delays, timers, PID loops, and alarm latching. All PID loops shall maintain stable operational performance.

**1.03 RELATED WORK IN OTHER SECTIONS**

A. Refer to Division 0 and Division 1 for related contractual requirements.

B. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.

C. Refer to Division 23 and the following sections for Mechanical or Electrical Provision.

1. Division 01 - Submittal Procedures
2. Division 01 - Commissioning
3. Section 230500: Basic HVAC Materials and Methods
4. Section 230593: Testing, Adjusting, and Balancing
5. Section 230902: Variable Frequency Drives
6. Section 232113: Hydronic Piping, Valves and Specialties
7. Section 232123: Hydronic Pumps
8. Section 233113: Air Distribution
9. Section 237315: Multizone Air Handling Units
12. Sections 237000 through 238999 equipment
13. Division 26 – Electrical Materials and Methods
14. Division 27 – Communications Systems
15. Division 28 – Electronic Safety and Security

D. Refer to Division 26 sections for Electrical Provisions. Sources of 120-volt electrical power as indicated on the electrical drawings and specifications for control system components furnished by this section. The controls contractor shall be responsible for all additional electrical distribution from these connection points to the control panels and other controls devices.

E. BAS contractor will furnish, but not install the following:

1. Air flow measuring stations: furnish to mechanical installer and coordinate per manufacturer's requirements.
2. Flow meters: furnish to mechanical installer and coordinate per manufacturer's requirements.
3. Flow switches: furnish to mechanical installer and coordinate per manufacturer's requirements.
4. Hydronic pressure and temperature sensor wells: furnish to mechanical installer and coordinate per manufacturer's requirements.
5. Control valves: furnish to mechanical installer and coordinate per manufacturer's requirements.

**1.04 DEFINITIONS**

A. ASHRAE: American Society of Heating, Refrigerating, and Air-conditioning Engineers

B. BACnet: BACnet is a preferred communications protocol for building automation and control networks. It is an ASHRAE, ANSI, and ISO standard protocol. BACnet MS/TP is utilized with EIA/RS 485 hardware and BACnet/IP with Ethernet.

C. BAS: A system that optimizes the start-up and performance of HVAC equipment and alarm systems. A BAS greatly increases the interaction between the mechanical subsystems of a building, improves occupant comfort, lowers energy use, and allows off-site building control.

D. Modbus: One of industry standard communication protocols supported by NTMC. Developed by Modicon, Inc., North Andover, MA.

E. ODVA™: (Open DeviceNet Vendors Association) An international organization that supports computing network technologies based upon the Common Industrial Protocol (CIP). These include DeviceNet, EtherNet/IP, CIP Safety and CIP Sync.

F. RTD: Resistance temperature detector is a sensor whose resistance changes with temperature.

G. SCADA System (Supervisory Control And Data Acquisition): A type of industrial control system; a computer system which monitors and controls industrial, infrastructure, or facility-based processes.

H. Transducer: A device that converts variations in a physical quantity, such as pressure or brightness, into an electrical signal, or vice versa.

I. Transmitter: A set of equipment used to generate and transmit electromagnetic waves carrying messages or signals.

**1.05 REFERENCE STANDARDS**

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. ASHRAE Guideline 36-High Performance Sequences of Operation of HVAC Systems
2. ANSI/ASHRAE Standard 135, BACnet.
3. International Building Code (IBC), including local State and Local amendments.
4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
5. National Electrical Code (NEC).
6. FCC Part 15, Subpart J, Class A.
7. EMC Directive 89/336/EEC (European CE Mark).
8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

**1.06 GENERAL REQUIREMENTS**

A. Furnish a distributed logic BACnet-based control system including the operator’s workstation. The operator’s workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2016, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system’s functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

B. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

C. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

D. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

E. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices. All Ethernet and structured cabling must be installed and tested per ANSI/TIA-568-D (latest revision) and any other applicable standards.

F. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

G. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

H. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

I. Provide a comprehensive operator and technician training program as described herein.

J. Provide as-built documentation, operator's terminal software, a software key for a minimum of one additional computer (coordinate with Owner's Representative if additional keys are required), diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

K. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

## 1.07 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2016, BACnet and achieved listing under the BACnet Testing Laboratories BACnet. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. The Building Automation System (BAS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. All application controllers for every piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet LAN.

E. Room sensors shall be provided with digital readout that allow the user to view room temperature, CO2 or relative humidity, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

## 1.08 QUALITY ASSURANCE

A. The BAS shall be designed, installed, commissioned, and serviced by contractor authorized and trained personnel. System provider shall have an in-place support facility within two (2) hours

response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.

B. The manufacturer and installer shall have a minimum of 5 years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. A list of successful past projects of similar type, size and complexity shall be submitted. In addition, a reference list of names, addresses and telephone numbers of the design Engineer and the Owner's Representative for each installation shall be provided. The references may be contacted and questioned about the timely delivery, installation, operation and service received for each installation.

C. The contractor shall provide experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.

D. The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

E. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.

F. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

H. Control system shall be engineered, programmed and supported completely by representative's local office that must be within 100 miles of project site.

I. Control components shall be products of the same manufacturer only, unless indicated otherwise and approved by Owner's Representative. Example – all valves shall by one manufacturer and all temperature sensors shall be by one manufacturer.

**1.09 SUBMITTALS**

A. Drawings

1. The system supplier shall submit point-to-point engineered drawings, control sequence, and bill of materials for approval. Sequences of operation shall use the Contract Documents as a starting point but shall not copy-and-paste the content of the Contract Documents as the sole submittal content; all submitted sequences of operation shall fully cover all aspects of operation in plain language format.
2. Drawings shall be submitted in electronic format.

B. System Documentation

1. Include the following in submittal package:
    a. System configuration diagrams in simplified block format.
    b. All input/output object listings and an alarm point summary listing. Alarm points shall indicate latching/non-latching and delay.
    c. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
    d. Complete bill of materials, valve schedule with Cv, valve pressure drop at design flow, and damper schedule.
    e. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.

f. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
g. For all system elements—operator's workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2016.
h. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.
i. A list of all functions available and a sample of function block programming that shall be part of delivered system.
j. Cut sheets of all equipment and components to be used as part of the BAS system with exact models, options, and accessories graphically indicated for review.
k. Complete list of all available and selected read/write points from integrated equipment controllers for review by Engineer.

C. Project Management

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

**1.010 WARRANTY**

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

C. Warrant work as follows:

1. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Warrant all actuators for a period of five (5) years.
3. Respond during normal business hours within 24 hours of Owner's warranty service request.
4. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
5. If Owner determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Owner will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
6. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
7. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

D. Occupancy sensors: 5-year manufacturer warranty.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Acceptable BAS Manufacturers include:

1. Schneider Electric

### 2.02 WEB INTERFACE

A. General

1. BAS supplier shall provide Web-based access to the system as part of standard installation. User must be able to access all displays of real-time data that are part of the BAS using a standard Web browser. Web browser shall tie into the network through Owner-supplied Ethernet network connection. Web page host may be a separate device that resides on the BAS BACnet network, but is not the BAS server for the control system. BAS server may be a separate computer from the Web page host device. The Web page software shall not require a per-user licensing fee or annual fees. The Web page host must be able to support simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

B. Browser Technology

1. No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable and the webpage host shall directly access real-time data from the BAS BACnet network. Data shall be displayed in real-time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.

C. Communications

1. Web page host shall support Ethernet network connections. A network connection shall be used to gather real-time data from all the BACnet devices that form the BAS. This network shall communicate using BACnet, allowing the Web page host to gather data directly from units on the local LAN or from other projects connected over a WAN. This network shall also provide the connection to the BAS server for Web page generation.
2. An Ethernet connection shall provide the physical connection to the Internet or an IP-based WAN. It shall be the port that is used for the browser to receive Web pages and data from the Web page host. The Web page host shall act as a physical barrier between the BAS network and the WAN or Internet connection that allows the browser to receive Web pages and data. The two separate network connections provide for a physical barrier to prevent raw BACnet traffic being exposed on the IP network.
3. The Web page host shall provide for complete isolation of the IP and BACnet networks by not routing networking packets between the two networks.

D. Display of Data

1. Web page graphics shown on browser shall be replicas of the BAS displays. User shall need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays shall include animation just as BAS displays. Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.
2. Real-time data shall be shown on all browser Web pages. This data must be directly gathered using the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
3. It shall be possible for user from browser Web page to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.

4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

E. Time Schedule Adjustment

1. Web access shall allow user to view and edit all schedules in the system. This includes three types of schedules: standard, holiday and event. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.
2. Display of all three schedule types must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

F. Logging of Information

1. User shall use standard browser technology to view all trend logs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust Y axis of data viewed in graphical format. User shall also be able to download data through the Web interface to local computer. Data shall be in CSV format.

G. Alarm Handling

1. Web interface shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user-selected time frame. In addition, those alarms may be filtered for viewing per user-selected options. A single selection shall display all alarms that have not been acknowledged.

H. Web Page Generation

1. Web pages shall be automatically generated from the BAS displays that reside on the BAS server. User shall access Web page host through the network and shall initiate a Web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access using any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.

I. Password Security and Activity Log

1. Access through Web browser shall utilize the same hierarchical security scheme as BAS system. User shall be asked to log on once the browser makes connection to Web page host. Once the user logs in, any and all changes that are made shall be tracked by the BAS system. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged in to the system, regardless of whether those changes were made using a browser or through the BAS workstation.

J. BACnet Communication

1. Web server shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

## 2.03 BUILDING NETWORK CONTROLLER

A. Building Network Controller
   1. BACnet Conformance
      a. Building Network Controller shall be approved by the BACnet Testing Laboratories as meeting the BACnet Building Controller requirements.

B. Building network controller modules shall provide normal 7-day scheduling, holiday scheduling and event scheduling.
   1. Logging Capabilities
      a. Logs shall be supported in the building network controller. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
      b. Logs may be viewed both on-site or off-site using WAN or remote communication.
      c. Building network controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.
      d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
   2. Alarm Generation
      a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
      b. Each alarm may be dialed out as noted elsewhere.
      c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
      d. Controller must be store alarms as BACnet event enrollment objects, with system destination and actions individually configurable.
   3. Demand Limiting
      a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
      b. Load shedding programs in building controller modules shall operate as coordinated with local utility.
   4. Tenant Activity Logging
      a. Tenant activity logging shall be supported by building network controller module.

C. BACnet/IP

1. This module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
2. All communication with operator's workstation, all application controllers and any other network hosts, shall be through BACnet/IP using standard ISO network layer 2 and layer 3 conventions and protocols.
3. All network cabling shall be installed and tested per ANSI/TIA-568-D (latest version). Only star type cabling configurations (each host connected to a dedicated switch port) is acceptable. Network hubs are not acceptable.
4. For categorized copper cabling (CAT5e, 6, and above) the maximum permalink length is 90 meters with an additional 10 meters allowed for patching and work space.
5. All communications as a minimum, must be configured to Fast Ethernet (100 megabits/second) or faster.

6. For IOT and IIOT devices, PoE (IEEE 802.3af), PoE+ (IEEE 802.3at), and PoE++ (IEEE 802.3bt type 1 & type 2) are acceptable when supported by a PoE rated switch or midspan injector.

D. MS/TP Module

1. MS/TP module shall support every listed function in this specification and the following.
2. Building controller MS/TP module communications shall be though BACnet MS/TP ASNI/EIA/RS-485-A LAN to all advanced application and application-specific controllers. Configure data rates to the maximum reliable settings (minimum bit-error rates) possible. ANSI/EIA/RS-422 & 232 based systems are not allowed.

E. Other BACnet Media

1. Although the BACnet standard supports other media types and configurations (Ethernet, ARCNET, P2P, LonTalk and Zigbee) these implementations are not considered authorized unless previously approved by the owner and engineer of record.

F. Power Supply Module

1. Input for power shall accept between 17–30VAC, 47–65Hz.
2. Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of all data in flash memory and for continuous operation of real-time clocks for minimum of 20 days.

G. Modbus Module

1. Modbus Module shall support every function as listed in this specification.
2. Building Controller Modbus module communications shall be ANSI/EIA/RS-485 only. Modbus module shall convert Modbus data into BACnet objects. Modbus module shall also route messages to Ethernet-MS/TP module for BACnet Ethernet communication over WAN.
    a. Modbus Module shall support ASCII or RTU Modbus communication at 9600 or 4800 baud.
    b. EIA-485 connection shall support connections of up to 247 Modbus units.
3. BACnet Translation
    a. All Modbus data shall be translated into BACnet objects by the Modbus module. All configuration tools shall be supplied to assure data is translated as necessary to the correct format and value.
    b. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

## 2.04 APPLICATION CONTROLLERS – GENERAL

A. All application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

B. All program sequences shall be stored on board controller in memory. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller ten(10) times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be

programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

C. Provide all application controllers with a minimum of 10% spare points for analog input, analog output, digital input and digital output signals.

**2.05 APPLICATION CONTROLLERS –AIR HANDLER OR CENTRAL PLANT**

A. Provide one or more native BACnet application controllers to adequately cover all objects listed in object list. All controllers shall interface to the building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. The programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

C. Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

D. Schedules

1. The controller shall support a minimum of three (3) BACnet Schedule Objects and have a real-time clock on board with battery backup to maintain time through a power loss.

E. Logging Capabilities

1. Controller shall support a minimum of 50 trend logs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

F. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

G. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

**2.06 APPLICATION CONTROLLER – UNITARY MECHANICAL EQUIPMENT**

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building

controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

**2.07 APPLICATION CONTROLLER – SINGLE DUCT TERMINAL UNIT**

A. Provide one native BACnet application controller for each terminal unit that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator's workstation, portable computers, and special hand-held field tools shall not be needed for field calibration.

C. Provide duct temperature sensor at discharge of each terminal unit that is connected to controller for reporting back to operator's workstation.

**2.08 AUXILIARY CONTROL DEVICES**

A. Temperature Sensors (TS)

1. Duct air temperature (duct mounted, indoor location)
    a. Thermistor type with 1/4" stainless steel probe and junction box. 10K ohm, type II, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend 25% (minimum) to 50% (maximum) into the width of duct. Manufacturer: Veris #TF Series, Dwyer Instruments #TE-DFG Series, Kele (Minco) #TT Series.
2. Duct air temperature (duct mounted, outdoor location)
    a. Thermistor type with 1/4" stainless steel probe and weather-tight junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend 25% (minimum) to 50% (maximum) into the width of duct. Manufacturer: Veris #TG Series, Dwyer Instruments #TE-DFW Series, Kele (Minco) #TT Series.
3. Outside air temperature (wall mounted location)
    a. Thermistor type with stainless steel or platinum probe and weather-proof aluminum junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe encased in durable radiation shield with radiation solar shield. Manufacturer: Veris #TO Series, Dwyer Instruments #TE Series.
4. Pipe or tank fluid temperature (immersion probe)
    a. Immersion probe type temperature sensor encased in a corrosion-resistant stainless steel thermowell. Thermistor type with metallic housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Manufacturer: Veris #TIG Series, Dwyer Instruments #TE Series.
5. Temperature averaging (coil mounting)
    a. Thermistor type with bendable copper tubing element water-resistant junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend across coil face at least twice to cover two corners and one midpoint. Mounting of tubing shall utilize Veris #AA64 mounting clips. Manufacturer: Veris #TA Series, Kele #ACI Series.

B. Intelligent Room Temperature Sensor (TS) with LCD Readout

1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit and allow occupant to raise and lower setpoint, and activate terminal unit for override use-all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
2. The intelligent room sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in degrees Fahrenheit or Centigrade.
3. Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.
4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

C. Humidity Sensors

1. Indoor space humidity (wall mounted inside):
   a. 1% accuracy thin film capacitive replaceable sensor element, LED display. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
   b. Manufacturers: Veris #HW Series, Dwyer Instruments #RHP-W Series.
2. Outside air humidity (wall mounted outdoors):
   a. 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
   b. Manufacturers: Veris #HO Series, Dwyer Instruments #RHP-W Series.
3. Duct air humidity (duct mounted indoor application):
   a. Humidity sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
   b. Manufacturers: Veris #HD Series, Dwyer Instruments #RHP-W Series.
4. Indoor space humidity with temperature (wall mounted inside):
   a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, LED display, push button override and setpoint slider. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
   b. Manufacturers: Veris #HW Series, Dwyer Instruments #RHP-W Series, Vaisala #HMW Series.
5. Outside air humidity with temperature (wall mounted outside):
   a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
   b. Manufacturers: Veris #HO Series, Dwyer Instruments #RHP Series, Vaisala #HMS Series.
6. Duct air humidity and temperature (duct mounted indoor application):

a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
b. Manufacturers: Veris #HD Series, Dwyer Instruments #RHP Series, Vaisala, #HMT Series.

7. Duct high limit humidity switch (duct mounted indoor application):
   a. Single-stage duct hygrostat with insertion probe to monitor humidity level with NO and NC contacts. Adjustable relative humidity setpoint range of 35 to 100% RH. SPDT 250 Vac/ 15 amp.
   b. Manufacturers: Honeywell #H6045A1002.

D. CO2 Sensors
1. Indoor space measurement (wall mounted):
   a. Non-dispersive infrared sensor in high impact white ABS plastic enclosure. Input power 20 to 30 VDC/24 AC, 100 mA. Analog output 4-20 mA. Operating range 32°F to 122°F (0°C to 50°C). Measurement range of 0-2000 ppm with accuracy of +/- 30 ppm.
   b. Manufacturers: Veris #CWE Series, Dwyer #CDT Series.
2. Outdoor air measurement (indoor duct mounted location):
   a. Non-dispersive infrared sensor in high impact white ABS plastic enclosure. Input power 20 to 30 VDC/24 AC, 100 mA. Analog output 4-20 mA. Operating range 32°F to 122°F (0°C to 50°C). Measurement range of 0-2000 ppm with accuracy of +/- 30 ppm.
   b. Manufacturers: Veris #CDE Series, Dwyer #CDT Series.

E. CO2, Humidity, Temperature Combined Sensor (Indoor Wall and Duct Mounted)
1. High impact white ABS plastic enclosure with digital LCD display and adjustable setpoints.
2. Input power 20 to 30 VDC/24 AC, 100 mA.
3. Analog output 4-20 mA.
4. Operating range 32°F to 122°F (0°C to 50°C).
5. CO2 Sensor: Non-dispersive infrared sensor in. Measurement range of 0-5000 ppm with accuracy of +/- 30 ppm.
6. Humidity Sensor: Digitally profiled thin-film capacitive, plus or minus 2% RH. 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
7. Temperature Sensor: Thermistor. 2% accuracy thin film capacitive replaceable sensor element.
8. Manufacturers: Veris #CWLP Series.

F. Occupancy Sensor
1. Low-profile, dual technology sensor with 360 degree detection. UL and cUL listed.
2. Construction:
   a. Dual-element, temperature-compensated pyroelectric sensor
3. Features:
   a. Immunity to RFI and EMI to eliminate false triggers.
   b. Time delay adjustment from 30 seconds to 30 minutes.
   c. Two levels of sensitivity, adjustable with physical switch.
   d. Isolated relay with normally open and normally closed outputs, rated 1A @ 24VDC/VAC.
   e. 24VAC/VDC voltage +/- 10%.
   f. Mounting hardware for ceiling tile or gypsum board with mud ring.
4. Manufacturers: Wattstopper (Legrand) #CI-24.

G. Leak Detector

1. Water leak detector connected to BAS to alarm on detecting the presence of water in the following locations:
    a. Secondary condensate drip pan below air conditioning air handling units and fan coils located above spaces with electrical and/or electronic equipment.
    b. Below raised access floors with one sensor per 5,000 square feet (maximum) where water pipes are located below access floor. Or, one sensor per 10,000 square feet (maximum) where no water pipes are located below access floor.
    c. On the floor adjacent to sump pump(s).
    d. On the floor of mechanical rooms adjacent to electrical equipment and/or data/electronics equipment rooms.
2. Features:
    a. Mounting: Base mounted.
    b. Service: water of conductive fluids.
    c. Sensing gap: Minimum 1/8" (3 mm) to maximum 1/4" (6 mm).
    d. Switch type: DPDT relay.
    e. External power: 1 A @ 24 VAC/DC.
    f. Audible alarm: 85 dB @ 1' distance (0.3 m).
    g. Visual indicators:
        1) Green to indicate power is supplied.
        2) Red to indicate water is detected.
    h. Temperature limits: 32 to 122°F (0 to 50°C).
    i. Flammability: plenum rated electrical cable with length as required and UL-94 compliant housing.
    j. Attached with 1/16" thick double sided adhesive urethane foam tape.
3. Manufacturers: Dwyer #WD3-LP-D2-A, Kele, Veris.

H. Condensate Sensor (Pipe):
1. Solid state condensate detector for locating condensate on chilled water piping. Sensing of water shall provide a signal to the BAS system for control sequence adjustment to raise chilled water temperature.
2. Features:
    a. Service: mounted on metallic pipe from 1/2" to 3" in diameter.
    b. Sensing: 80% to 90% RH (adjustable) surface moisture.
    c. Switch type: SPST open/close.
    d. External power: 40 mA at 24 VAC or 20 mA at 12 to 30 VDC.
    e. Temperature limits: 149°F (65°C).
    f. Flammability: plenum rated electrical cable with length as required and UL-94 compliant housing.
    g. Mounting bracket with stainless steel worm gear clamp for attachment.
3. Manufacturers: Consense #CG-ICM-P.

I. Differential Pressure Transmitters:
1. Duct Static Pressure Transmitter:
    a. Differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero, LCD display.
    b. Manufacturers: Veris #PX Series, Dwyer Instruments #MS2, Kele #DPA Series.
2. Building Static Pressure Transmitter:

a. Differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero. Provide with AA05 ceiling mount static pressure pick up, LCD display.
b. Manufacturers: Veris #PX Series, Dwyer Instruments #MS2, Kele #DPA Series.

3. Water differential pressure transmitter:
   a. Differential pressure transmitter, wet/wet, switch selectable pressure ranges, jumper selectable port swap, LCD display and NEMA 4 enclosure.
   b. Manufacturers: Veris #PW Series, Dwyer Instruments #MS2.

J. Differential Pressure Switches:

1. Filter differential pressure switch for status:
   a. Adjustable differential pressure switch, dual scale adjustable knob, silicone diaphragm, single-pole double-throw type, 1/4" tubing diameter, setting range from 0.08 in. w.c. (20 Pa) up to 20 in. w.c. (5000 Pa), and NEMA-3 enclosure.
   b. Manufacturers: Dwyer #ADPS Series.
2. Duct static manual reset high pressure safety switch for supply fan shut down:
   a. Adjustable trip and manual reset, single-pole double-throw, 120-480 VAC. Maximum operating range of -30°F to 180°F (-34°C to 82.2°C) and humidity limit of 80% RH non-condensing. Provide weatherproof housing where mounted outdoors. Adjustable setpoint between 3.0 to 11.75 in. w.c.
   b. Manufacturers: Dwyer #1900-10-MR Series.
3. Duct static manual reset high pressure safety switch for return fan shut down:
   a. Adjustable trip and manual reset, single-pole double-throw, 120-480 VAC. Maximum operating range of -30°F to 180°F (-34°C to 82.2°C) and humidity limit of 80% RH non-condensing. Provide weatherproof housing where mounted outdoors. Adjustable setpoint between 1.40 to 5.5 in. w.c.
   b. Manufacturers: Dwyer #1900-5-MR Series.

K. Air Filter Differential Pressure Gauges: (where not supplied by air handling equipment manufacturer):
1. Dial type, diaphragm-actuated with external zero adjustment and 3-7/8-inch diameter dial.
2. With two (2) static pressure tips, 2-way valves, tubing and mounting plate (and adjustable signal flag).
3. Range as recommended by filter manufacturer.
4. One gauge per filter bank for direct field verification independent of BAS monitoring.
5. Manufacturers: Dwyer 2000 Series Magnehelic.

L. Current Sensors
1. Current sensing switch for constant speed fans and pumps to detect belt loss, coupling shear and mechanical failure:
   a. Current switch with split core, adjustable trip, pilot light, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #HX08 Series.
2. Current sensing switch for VFD controlling multiple fans and pumps:
   a. VFD current switch split core, self-learning adjustable trip, pilot light, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #H614.
3. Current sensing switch with fixed trip point for monitoring constant speed direct-drive fans, recirculating pumps or other fixed loads:

a. Current switch with split core, fixed trip, self-gripping split core housing and mounting bracket.
b. Manufacturers: Veris #HX00 Series.

4. Current sensing switch with fixed trip point for monitoring constant speed EC motor fans, recirculating pumps or other fixed loads:
   a. Current switch with split core, fixed trip, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #H6ECM05 Series.
5. Current sensing transmitter for load trending with proportional 4 to 20 mA output signal:
   a. Current sensing transmitter with self-gripping split core, preset slide switches, and removable mounting bracket.
   b. Manufacturers: Veris #H921.
6. Current sensing transmitter with relay for fan start/stop control and status monitoring of motors:
   a. Current sensing transmitter with integral relay, slide switches, self-gripping split core, and removable mounting bracket.
   b. Manufacturers: Veris #H931.

M. Flow Meters – Liquid:
1. Single turbine insertion flow meter:
   a. 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple, and branch outlet. Provide with D-100 totalizing display module with BACnet interface.
   b. Manufacturers: Onicon #F-1100, Badger Meter #Impeller SDI Series.
2. Electromagnetic inline flow meter for high accuracy flow measurement of clean fluid in a closed loop:
   a. Accuracy: +/- 0.25% with bidirectional flow capability. Maintain minimum of three (3X) straight pipe diameters upstream and two (2X) pipe diameters downstream when installed greater than seven (7X) pipe diameters downstream of a pump.
   b. Electrodes: Two electrodes for flow measurement, one electrode for empty pipe detection, and one electrode for grounding as required by piping system. Constructed of Hastelloy C22, 316 stainless steel, gold, platinum or tantalum.
   c. Pipe spool: 316 stainless steel.
   d. Flanges: ANSI B16.5 carbon steel, 304 or 316 stainless steel.
   e. Housing: NEMA 4X weather tight aluminum enclosure, or carbon steel or stainless steel. Powder coated.
   f. Power: 120 VAC or 24 VDC.
   g. Connections: Four programmable digital outputs (minimum), one analog programmable and scalable output, and one digital input.
   h. Totalizing display: Backlit with minimum four rows of text with BACnet interface.
   i. Ambient operating temperature range: -4°F to 140°F (-20°C to 60°C).
   j. Fluid temperature to maximum of 212°F (100°C).
   k. Manufacturers: Badger Meter #ModMAG M2000, Onicon #FT-3000.
3. Ultrasonic clamp-on flow meter (for metal piping installation only):
   a. Accuracy: +/- 1% with bidirectional flow capability. Maintain minimum of ten (10X) straight pipe diameters upstream and five (5X) pipe diameters downstream when installed greater than 24 pipe diameters downstream of a pump, header or valve.

b. Transducers: Two ultrasonic transducers function as both transmitters and receivers. Volumetric flow measurement is made by measuring the difference time between two digitally synthesized contra propagating acoustic waves traveling between the two ultrasonic transducers positioned lineally, a known distance apart, on the outside of a closed pipe.
c. Housing: NEMA 4 or 4X weather tight aluminum enclosure.
d. Transducer housing: PVC, CPVC, PTFE or PBT glass filled as required by fluid operating temperature.
e. Power: 120 VAC or 24 VDC.
f. Connections: Two programmable digital outputs (minimum), one digital input, and one 4-20 mA output.
g. Totalizing display: Backlit with minimum four rows of text with BACnet interface.
h. Ambient operating temperature range: -4°F to 140°F (-20°C to 60°C).
i. Fluid temperature to maximum of 212°F (100°C).
j. Flow meter may also be used with energy meter.
k. Manufacturers: Badger #Dynasonics TFX-5000, Siemens #Sitrans FS230.

4. Electromagnetic insertion meter for medium accuracy flow measurement of a clean fluid in a closed loop:

a. Insertion type Electromagnetic.
b. Accuracy: +/- 1%. Maintain minimum of ten (10X) straight pipe diameters upstream and five (5X) pipe diameters downstream when installed greater than 30 pipe diameters downstream of a header or valve.
c. Sensor: Stainless steel with empty pipe signal.
d. Power: 24 VDC.
e. Connections: One digital output and one 4-20 mA output.
f. Ambient operating temperature range: 32°F to 140°F (0°C to 60°C).
g. Fluid temperature to maximum of 212°F (100°C).
h. Flow meter may also be used with energy meter.
i. Manufacturers: Onicon F-3500.

N. Flow Meters - Natural Gas:

1. Thermal mass flow meter, in-line or flanged. Provide with totalizing display module with BACnet interface.
2. Manufacturers: Onicon #F-5100 Series, Badger Meter #VN-2000.

O. BTU Meters:

1. BTU meter with BACnet interface with matched temperature sensors and thermo-wells, NEMA 4X wall mount enclosure, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple, and branch outlet.
2. Manufacturers: Onicon #System-10 and provide with Onicon #F-1100 single turbine insertion flow meter, or Onicon #F-3500 electromagnetic flow meter, or equal by E-Mon D-Mon or Badger.

P. Airflow Measuring Arrays

1. Provide one thermal dispersion airflow/temperature measurement device (ATMD) at each location indicated on the plans, schedules and/or control schematics.
2. Each ATMD shall consist of one to four sensor probes and a single, remote transmitter. Each sensor probe shall consist of one to eight independent sensor nodes in a gold anodized, aluminum 6063 alloy tube with 304 stainless steel mounting brackets.
3. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Chip thermistors of any type or packaging are not acceptable.

4. The velocity-weighted average temperature output performance of the ATMD is preferred to that of the specified temperature measuring device (TMD), when the location of the ATMD and TMD are effectively the same.
5. Outside Air Measurement:
    a. Provide a minimum outside airflow measuring station in a straight duct section upstream from the minimum outside air dampers and interfacing control for providing an electronic signal for use by the control contractor in controlling a minimum outside airflow. On outdoor mounted air handling units, outside airflow measurement station is to be factory mounted on the intake side of the outside air intake (upstream of the damper).
6. Sensor Performance:
    a. Fan Installation:
        1) Installed airflow accuracy: +/- 3% to 10% of reading with +/- 0.25% repeatability.
        2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, +/- 0.15□F temperature accuracy.
    b. Outside Air/duct Installation:
        1) Installed airflow accuracy: +/- 2% of reading with +/- 0.25% repeatability.
        2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, +/- 0.15□F temperature accuracy.
7. Transmitter:
    a. Flow measuring array to include a transmitter for flow and temperature analog output signal for the building energy management system to be user selectable in either 4-20 mA or 0-10VDC. Coordinate signal output with controls installer.
    b. Transmitter to include an analog airflow gauge to provide direct analog readout in cfm. Mount on the outside of the air handler if air handler is located in a mechanical room. Mount in a NEMA 3R control cabinet if located outside.
    c. Device to provide switch selectable Modbus or Johnson N2 outputs.
    d. Device to be UL listed.
    e. The transmitter shall be powered by 24 VAC, shall include over-voltage and over-current protection, and shall include watchdog circuitry to ensure continuous operation following power failures and/or brown- outs.
    f. The transmitter shall determine the airflow rate and temperature of each sensing node prior to averaging.
    g. The transmitter shall include self-diagnostics and other features to ensure reliability and continued operation despite a limited failure. The transmitter shall automatically detect sensor damage and correctly calculate the average using the remaining functional sensor nodes, while reporting a system fault over the network and by local visual indication.
    h. All integrated circuits shall be industrial rated for operation down to -40°F (-40°C).
    i. The environmental operating temperature limits for the transmitter shall be -20°F to 120°F (-29°C to 49°C).
    j. The system shall be factory tested prior to shipment and not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines.
    k. The Sensors shall be calibrated to NIST traceable standards.
8. Manufacturers: Ebtron, Paragon Controls, Dynasonics.

Q. LED Pilot Lights
1. Provide wall mounted pilot lights to indicate when operable windows may be opened or closed based on outdoor weather conditions as determined by BAS. Mount adjacent to main access

door serving space with operable windows or adjacent to light switch, as shown on Architectural or Mechanical drawings. Coordinate final placement of pilot lights and color of cover plate with Owner's Representative.
2. Polycarbonate or steel wall box.
3. Wall plate color to match wall color. Color options shall include: ivory, white, black or stainless steel.
4. Continuous color indication. LED lights, 20-25 mm diameter. One green light located above one red light.
5. Voltage as selected by BAS installer, 12-volt or 24-volt, 20 mA, maximum.
6. Manufacturers: Signaworks #WP22 Series.

R. Flow Switch

1. Paddle type vane flow switch for insertion into pipe sizes 1" to 8". Forged brass body, stainless steel vane, and tin-bronze bellows. Maximum operating temperature to 230°F (110°C) and maximum operating pressure to 145 psig (10 bar). NEMA 4 enclosure, SPDT snap switch, 250 VAC (max). Connection using 1" male NPT or BSPT. Switch must be installed vertically on a horizontal pipe run.
2. Manufacturers: Dwyer #FS-2.

**2.09 ACTUATORS**

A. Electronic Actuators:

1. Size for torque required for damper seal at load conditions.
2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
3. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
4. Overload protected electronically throughout rotation.
5. Fail-Safe Operation: Mechanical, spring-return mechanism
6. Electronic Fail-Safe Operation: Incorporate a visual indication of the fail safe status on the face of the actuator. The power fail position shall be field adjustable between 0 to 100% in 10% increments. The electronic fail safe shall have a 2-10 second adjustable operational delay.
7. Power Requirements (Spring Return): 24-V ac, maximum 10 VA at 24-V ac or 8 W at 24-V dc (running). Maximum 1 VA at 24-V ac or 1 W at 24-V dc (holding).
8. Proportional Actuators shall be fully programmable through an onboard EEPROM by using an external cable and software interface.
9. Temperature Rating: -22 to +122ºF.
10. Housing: Minimum requirement NEMA type 2 mounted in any orientation. .
11. Agency Listings: ISO 9001, cULus, CE or CSA
12. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
13. Manufacturers: Belimo, Siemens, Honeywell, Keystone #777.

B. Actuators with torque requirements exceeding 360 inch-pounds:

1. The combination of valve and actuator shall meet the close-off requirements as specified in Section 2.16.H – Butterfly Valves.
2. Coupling: ISO 5211 mounting standards.
3. Overload Protection: A self-resetting thermal switch embedded in the motor.
4. Manual Override: Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the actuator in the event of an electrical power failure
5. Power Requirements: 24VAC, 120VAC, or 230VAC single phase.
6. Auxiliary Switches: 2 SPDT rated 3A at 250 VAC.
7. Temperature Rating: -22 to +122ºF.

8. Duty Cycle Rated 75% minimum.
9. Housing: Minimum requirement NEMA type 4X/ IP67 with an industrial quality coating. Actuator shall have an internal heater to prevent condensation within the housing. A visual indication beacon shall indicate position status of the device.
10. Agency Listing: ISO, CE, CSA
11. The manufacturer shall warrant for 2 years from the date of production.
12. Manufacturers: Belimo, Siemens, Honeywell.

**2.010 CONTROL VALVES**

A. Manufacturer: Belimo, Siemens, Honeywell.

B. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).

C. Control Valve Actuators:

1. Size for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
2. Coupling: directly couple and mount to valve stem, shaft ISO-style direct-coupled mounting pad.
3. Non-spring return actuators shall have manual override
4. Spring return actuators of 90 inch-pounds or above shall have manual override.

D. Control Valves:

1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
2. Sizing (Water):
   a. Two-Position: Line size or size using a pressure differential of 1 psi.
   b. Two-Way Modulating: Size for a pressure differential across the valve of 4 psi at design flow, or twice the load pressure drop at design flow.
   c. Three-Way Modulating: Size for a pressure differential across the valve of not more than 4 psi at design flow
3. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system head pressure for two-way valves and 150 percent of the design pressure differential across the three-way valves.
4. The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.

E. Pressure Independent Control Valves: Pressure independent control valves to be used for all control valves scheduled for greater than eight (8) gpm unless otherwise noted on the plans.

1. NPS 2 and Smaller: Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc for equal percentage characteristic.
2. NPS 2-1/2 through 6: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
3. The control valve assembly shall have an integral magnetic flow meter Magnetic flow meter to accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSID across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
4. Flow Characteristics: NPS 1/2” through 2” Equal percentage characteristic. NPS 2-1/2” through 6” capable of Equal percentage or Linear characteristic (field programmable).

5. All proportional actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
6. Actuators for 3-wire floating (tri-state) and on 2 position (on/off) on 1/2" to 1" pressure independent control valves shall fail in place.
7. Water Coil optimization 2-1/2" through 6" shall be accomplished by utilizing an energy meter (a pressure independent control valve assembly) with two integral temperature sensors providing feedback of coil inlet and coil outlet water temperature; and integral magnetic flow meter for control and to provide actual analog flow feedback. Valve assembly to have built in intelligence to control pressure independently and a Delta T Manager mode to mitigate low delta T syndrome by referencing an internally programmed design delta T setpoint. Valve assembly shall be capable of communicating data by means of BACnet MS/TP, BACnet I/P and TCP IP. Data to include, but not be limited to, inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr. Valve assembly shall be capable of trending and storing up to 13 months of data on the actuator. Trended data on actuator to be retrievable via TCP IP or direct connect and download to *.csv file format.
8. The manufacturer shall provide a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).
9. The control valve shall require no maintenance and shall not include replaceable cartridges.
10. NPS 2" and smaller pressure independent control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain an integrated isolation ball valve/manual air vent with strainer/shut-off valve/drain with pressure/temperature test ports. The return side shall contain a union fitting with a pressure/temperature test port, pressure independent control valve, and integrated isolation ball valve/manual air vent with a pressure/temperature test port. Shut-off valves as an integrated part of the pressure independent control valve are prohibited. A braided stainless flexible hose shall be provided for each coil supply and return connection for all pipe packages.

F. Characterized Control Valves: Characterized control valves to be used for all control valves scheduled for eight (8) gpm or less unless otherwise noted on the plans.
   1. NPS 1/2" and smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi WOG Water oil gas, chrome plated brass Stainless steel stem is an option ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
   2. NPS 1" through 2": Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
   3. NPS 2-1/2" through 6": GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
   4. Flow Characteristics: Equal percentage characteristics.
   5. Six-way control valve used for chilled beam applications shall have the following characteristics:
      a. NPS 1/2" and 3/4": Nickel plated forged brass body rated at no less than 600 psi, dual chrome plated brass ball and blowout proof stems, and female NPT end fittings. Each three-way portion of the 6-way valve body shall have EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
      b. The six-way control valve shall be controlled by a rotary actuator for managing two media in a modulating application. The valve shall be closed to all flow at mid-rotation.

G. Butterfly Valves – Resilient Seat:
   1. NPS 2 to 12: Valve body shall be full lugged cast iron to meet ANSI 150 or 300 standards, with a 304/316/416 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. The shaft shall be supported at four locations by reinforced PTFE bushings.
   2. NPS 14 and Larger: Valve body shall be full lugged cast or ductile iron to meet ANSI 150 or 300 standards, with a 304/316/416 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by reinforced PTFE bushings.
   3. Sizing:
      a. Two-Position: Line size or size using a pressure differential of 1 psi.
      b. Modulating: 4 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position and a design velocity not to exceed 12 feet per second.
   4. Close-Off Pressure Rating: NPS 2-12" 200 psi bubble tight shut-off. NPS 14 and larger, 150 psi bubble tight shut-off.

H. Butterfly Valves – High Performance:
   1. Valve body shall be full lugged carbon steel body to meet ANSI Class 150 or 300 standards, as required, with a 316/416 stainless steel disc without a nylon coating, reinforced PTFE seat, and meet ANSI Class 150/300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed PTFE bushings. Valve packing shall be PTFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 2" insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.
   2. Sizing:
      a. Two-Position: Line size or size using a pressure differential of 1 psi.
      b. Modulating: 4 psig, or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position with the design velocity less than 32 feet per second.
   3. Flow Characteristics: Modified equal percentage, unidirectional.
   4. Close-Off Pressure Rating: 150 psi bubble tight shut-off.
   5. Media Temperature Range: ANSI Class 150 limitations.
   6. Max Differential Pressure: 285 psi @ 100°F for ANSI 150 (725 psi @ 100°F for ANSI 300).

I. Equipment Isolation Valves:
   1. Slow Closing/Quick Opening Solenoid Valve (2-Way/2-Position), 1/2" to 2-1/2":
      a. Class 125, brass body, stainless steel core, snubber slows disc closing to protect system against water hammer, minimum operating pressure differential 5 psi, 120 VAC input, normally closed (closed when deenergized). Lead-free construction and UL/NSF compliant. Valve shall full stroke close in 4 to 10 seconds and open immediately when energized. Manufacturers: Asco Redhat #8221.
   2. Butterfly Valves, 2-1/2" and larger:
      a. Valve body shall be full lugged cast iron body and shall meet ANSI Class 125/150 flange standards. Disk shall be aluminum bronze or 304/316/416 stainless steel with EPDM seat and extended neck as required to accommodate insulation. The shaft shall be supported at four locations by reinforced PTFE bushings.

b. Valve actuator with integrated linkage for 90° degree rotation and visual position indicator. Power supply with input voltage from 24 to 240 VAC. Power consumption in operation 20 watts and resting power consumption of 6 watts maximum. Adjustable running time of 30 to 120 seconds for full stroke. Ambient humidity to 95% RH non-condensing and operating temperature from -22°F to 122°F (-30°C to 50°C). Die cast aluminum Type 4X enclosure. Open/close or floating point operation as required by system operation. Manufacturer: Belimo #PR Series.

**2.011 ENERGY VALVE**

1. NPS 1/2" through 2":
   a. 2-way characterized control valve with tight close-off. Nickel-plated forged brass body rated at no less than 360 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and flow characterizing disc.
   b. Non-spring return or electronic fail-safe actuator with analog input and output
   c. Ultrasonic flow meter with temperature and glycol compensation.
   d. Supply and return temperature sensors with thermowells and pipe fittings.
2. NPS 2-1/2" through 6":
   a. 2-way characterized control valve with tight close-off. GG25 cast iron body according to ANSI Class 125 or Class 250 per system pressure class, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125/250 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
   b. Non-spring return or electronic fail-safe actuator with analog input and output
   c. Magnetic flow sensor.
   d. Supply temperature sensor with thermowell.
   e. Return temperature sensor embedded.

B. Manufacturer: Belimo.

**2.012 DOMESTIC WATER SECURITY VALVES**

A. Scope: connect to BAS for automatic opening and closing of domestic cold water supply to building.

B. Control Valve Actuator:
   1. High torque actuator, fast opening and closing to control incoming domestic cold water service.
   2. NEMA 6P waterproof enclosure.
   3. UL listed.
   4. Power supply input:100–240 volts, 60 Hz, 1 amp maximum. Output 18 volts, 2.22 amps.
   5. BAS feedback signals for valve open or closed.
   6. 12 VDC trigger contact to open valve.

C. Control Valve:
   1. 316 stainless steel, 3-piece construction for body, ball and stem.
   2. Equipped with a manual handle for emergency override.
   3. Pressure rated to 600 psi, minimum.
   4. Full port ball valve.
   5. Threaded for sizes 1/2" to 2".

D. Low lead and certified for potable water use per UPC and NSF/ANSI 61.

E. Manufacturer: Automatic Security Valves.

**2.013 WIRELESS SYSTEM**

A. Architecture and Communications:

1. Wireless equipment controllers and control devices shall conform to IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems. Equipment shall also comply with the following standards:
    1) UL 916: Energy Management Equipment
    2) UL 94: The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating
    3) UL 873: Temperature regulating and indicating equipment
    4) ZigBee Building Automation
    5) BACnet Tunneling
2. Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
3. Operating range shall be a minimum of 200 feet; open range shall be 2,500 ft. (762 m) with less than 2% packet error rate to ensure reliable operation.
4. To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
5. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
6. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E.
7. The system devices shall use direct sequence spread spectrum RF technology.
8. The system devices shall operate on the 2.4 GHZ ISM Band.
9. The system devices shall be FCC compliant to CFR Part 15 subpart B Class A.

B. Service Tools:
1. To support network setup and troubleshooting, service tools shall display link quality and hop quantities for each wireless device.
2. Wireless service tool access to communication link shall be provided to minimize installation and troubleshooting labor.

C. Construction:
1. Devices such as sensors, receivers and signal coordinators, intended to be installed in a return air plenum, shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB. Wall mounted devices may be assembled in NEMA-1 plastic enclosures.

D. Wireless Field Bus System:
1. The system shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for BACnet devices at multiple system levels. This includes communications from field controllers to sensors and from sensors to field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.
2. The field bus coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55 or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a coordinator for initiation and formation of the network
    a. The coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
    b. The coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).
    c. The coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.

3. A wireless field bus router shall be used with any controller and field device to provide a wireless interface to supervisory devices and associated wireless mesh room temperature sensors.
    a. The router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
    b. The router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
    c. The router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.

E. Wireless Room Temperature Sensors:
1. Wireless space sensors shall be capable of continuous operation in the following conditions:
    a. Ambient operating temperature range shall be 32°F to 122°F (0 to 50°C).
    b. Ambient operating and storage humidity range shall be 5 to 95%, non-condensing.
2. Wireless room temperature sensors shall sense and transmit room temperatures, room set point, room occupancy notification low battery condition to an associated router.
    a. The sensors shall be available with:
        1) Warmer/cooler setpoint adjustment or no setpoint adjustment.
        2) Setpoint adjustment scale: 55°F to 85º F (minimum range).
    b. Wireless sensors shall be provided with display of room temperature, signal strength, fan mode, occupancy and network status as required by application and indicated on plans or in the schedules.
3. Features:
    a. The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.
    b. To check for proper operation, wireless space temperature sensors shall include signal strength on the space sensor display.
    c. To support use by the physically impaired, the wireless space sensor shall be a minimum font size of 12 points, and the LCD model shall be readable in low light conditions.
    d. An optional 2% relative humidity sensors module shall be available for humidity control applications to minimize the need for wired sensors, and shall not shorten typical battery life to less than 15 years.
    e. Wireless space sensors shall be available as: temperature only, field configurable model with digital display, and optional 2% humidity module for use in either model above. The field configurable models shall all allow field configuration without a field service tool. Configuration options include: setpoint, override pushbuttons, fan speed, and system mode switches. System mode, fan speed and setpoint shall include a lock option. The digital display shall also be field configurable to display in Fahrenheit or Celsius units of measure, and can also be configured to display setpoint only.
    f. The wireless space sensor addresses shall be held in non-volatile memory to ensure operation through system voltage disturbances and to minimize the risk of incorrect association.
    g. The wireless space sensor shall be addressed using pushbuttons and display with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing.
    h. The wireless space sensor shall include security screws to protect against theft.
4. Accuracy:
    a. To ensure proper system performance, the wireless space sensors shall automatically determine when the space temperature is rapidly changing. When the space temperature is

rapidly changing, the space temperature shall be transmitted at least once each 30 seconds. The maximum time between transmissions shall be 15 minutes. Space temperature sensing accuracy shall be +/- 0.5°F (+/- 0.28°C).

F. Wireless Communications Interface:
   1. Wireless communication devices and receivers shall be capable of continuous operation in the following conditions:
      a. Ambient operating temperature range shall be 32°F to 122°F (0 to 50°C).
      b. Ambient operating and storage humidity range shall be 5 to 95%, non-condensing.
   2. Features:
      a. Wireless communications interface shall be addressed using rotary switches with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing.

G. Many-To-One Wireless Receiver:
   1. The Many-To-One System Receiver shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple wireless room temperature sensors.
   2. The receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
   3. The receiver shall be capable of communication with sensors up to a distance of 200 Feet.
   4. The receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
   5. The receiver shall have LED indicators to provide information regarding the following conditions:
      a. Power: on/off.
      b. Ethernet: receiver activity/no activity.
      c. Wireless Normal Mode: transmission from sensors/no transmission.
      d. Wireless Rapid Transmit Mode: no transmission/weak signal/adequate signal/excellent signal.
      e. Ethernet Connection: No connection/10Mbps connection/100Mbps connection
      f. Network Activity: No network activity/half-duplex communication/full-duplex communication.

H. One-to-One Wireless Receiver:
   1. The One-To-One Wireless Receiver shall receive wireless radio frequency (RF) signals containing temperature data from multiple wireless room temperature sensors and communicate this information to field controllers via the communication bus.
   2. The receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
   3. The receiver shall be capable of communication with from one to five sensors up to a distance of 200 Feet.
   4. The receiver shall have LED indicators to provide information regarding the following conditions:
      a. Power.
      b. Communication Bus: Receiver activity/no activity.
      c. Wireless RF: Transmission from sensors/no transmission.
      d. Wireless Rapid Transmit Mode: No transmission/weak signal/adequate signal/excellent signal.

I. System Tools:
   1. Wireless Space Sensor Installation and Configuration Tools
      a. To enable installation and servicing when specialized tools are required, site survey and installation tools as well as software shall be provided to the contractor use for system installation and commissioning for the duration of the warranty period.

b. To enable installation and servicing when specialized tools are required, site survey and installation tools as well as software shall be provided to the Owner for permanent possession for ongoing system maintenance and trouble shooting.

**2.014 ENCLOSURES**

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment.

C. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

D. Outdoor enclosures shall be NEMA 3R or NEMA 4X, as necessary for the site.

E. Enclosures shall have hinged, locking doors.

F. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

**2.015 PROGRAMMABLE THERMOSTAT**

A. Thermostat with 365 day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.

1. Manufacturers: Honeywell VisionPRO 8000 Series, Honeywell Prestige THX 9000 Series, Honeywell TB7600 Series, Venstar ColorTouch T6000 Series, EnTouch Pro/One.

B. Minimum thermostat features shall include, but not limited to, the following:

1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.
2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
3. The setback override shall be activated by a single button, and deactivated on demand.
4. Setpoints shall be adjustable from 35°F to 99°F, with a minimum 5°F adjustable deadband available.
5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75°F and heating setpoint of 70°F. Initial unoccupied mode cooling setpoint of 85°F and heating setpoint of 55°F.

C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.

1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
2. Emergency Heat switch will be provided on the touch screen when set in heat pump mode.

D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.

E. Controls shall be capable of alternating compressor starting sequence with a built-in lead-lag operating logic.

1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.

F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.
   1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.

G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.

H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

### 3.02 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

### 3.03 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum three (3) feet of clear access space in front of units. Obtain approval on locations from Owner's Representative prior to installation.

B. Wall mounted temperature sensors will typically be mounted directly above or below light switches and comply with ADA height requirements. Coordinate with Owner, Architect and other trades to assure proper mounted locations prior to installation.

C. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.

D. Identify all equipment and panels. Provide permanently mounted tags for all panels.

E. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections, and sized to suit pipe diameter without restricting flow.

F. Occupancy sensors: provide hardware as necessary to install within ceiling type as shown in the Contract Documents. Install per manufacturer's requirements for full coverage of occupant locations within space. Coordinate with other ceiling items.

## 3.04 CONDUIT

A. Conduit Requirements: all conduit shall with comply with minimum requirements of local authority having jurisdiction.
   1. Low voltage wiring in concealed areas may be plenum rated. Low voltage wiring in exposed areas shall be enclosed in conduit.
      a. All low voltage wiring exposed to weather shall be installed in conduit.
      b. Low voltage wiring in exposed areas, such as in mechanical, electrical, or service rooms, shall be installed in EMT conduit up to 10 feet above finished floor.
   2. All low voltage control wiring in critical facilities and critical locations shall be enclosed in conduit.

B. Provide rigid conduit for low voltage wring in walls for all wall mounted sensors, CO2 sensors, humidity sensors, etc. Conduit shall be run to 6" (minimum) above the ceiling and shall terminate with a bushing installed on the conduit end. Flexible conduit shall not be used.

C. Provide conduit for low voltage wiring above inaccessible ceilings.

D. Conceal all conduits, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 12 inches (30 cm) from high-temperature equipment (i.e.-such as flues or high temperature pipes).

E. Conduit must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

F. Secure conduits with conduit clamps fastened to the structure and spaced according to code requirements. Conduits and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.

G. Size of conduit and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

## 3.05 LOW VOLTAGE INTERLOCKING AND CONTROL WIRING

A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.

B. All low-voltage wiring shall meet NFPA-70 (NEC) Article 725 Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.

C. Do not install Class 2 wiring (greater than 100 volts and protected by overcurrent device not over 20 amperes) in conduits containing Class 1 wiring (not exceeding 30 volts and 1000 volt-amperes). Boxes and panels containing line voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

D. Unless otherwise noted, power wiring for all valve and damper actuators is Class 2. If the BAS contractor desires to substitute 120-volt actuators, the BAS contractor shall coordinate directly with the General Contractor and Electrical Contractor to provide all 120-volt wiring and conduit at no additional cost to the Owner.

E. Contractor shall provide step-down transformers as necessary.

F. Install insulated bushings on all conduit ends and openings to enclosures. Seal top end of vertical conduits.

G. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block. Wire nuts are not acceptable.

H. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

I. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

J. Use color-coded conductors throughout with conductors of different colors.

K. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

L. The contractor shall terminate all communications, control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

**3.06 COMMUNICATION WIRING**

A. The contractor shall adhere to the wiring requirement previously listed.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling

C. Do not install communication wiring in conduits and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to manufacturer’s instructions.

G. All runs of communication wiring shall be unspliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:

1. The network shall use shielded, twisted-pair or stranded cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot). Wire gauge and wire type shall be sized and coordinated with manufacturer load requirements and lengths of runs.
2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
4. An MS/TP EIA-485 network shall have no T connections.

K. All Ethernet cabling, routers, hubs and switches for connecting 230900 furnished and installed control panels, servers and clients to the building Owner’s Ethernet network are the responsibility of the BAS contractor.

**3.07 MOTORIZED DAMPERS**

A. Where ducts penetrate an exterior surface install a Class I motorized damper at each outdoor air supply opening, return air opening, exhaust opening, relief outlet, shaft vent and stairway vent, as required to comply with minimum requirements of the local Energy Code.

1. Dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the system served requires outdoor air or exhaust air or operates continuously or the dampers are opened to provide intentional economizer cooling.
2. Stairway and shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.

**3.08 FIELD SERVICES**

A. Prepare and start logic control system under provisions of this section.

B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation. Provide all labor and services as necessary to support testing and verification by third party commissioning authority.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.

D. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

**3.09 PROJECT RECORD DOCUMENTS**

A. Project Record Documents: Upon completion of installation, submit electronic copies of as-built documents. The documents shall be submitted for approval prior to final completion and shall include:

1. Project Record Drawings. As-built versions of the submittal shop drawings.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Part 3: "Control System Demonstration and Acceptance."
3. Operation and Maintenance (O & M) Manual.
4. As-built versions of submittal product data.
5. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
9. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.
10. Graphic files, programs, and database on magnetic or optical media.
11. List of recommended parts with part numbers and suppliers.
12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
14. Licenses, guarantees, and warranty documents for equipment and systems.
15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

16. Exported final sequences, diagrams, and points lists from the BAS at time of turnover.
17. All selected read/write points from integrated equipment and their labels.

**3.010 TRAINING**

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain BAS system.

B. Provide tuition for at least one individual to attend for a one-week factory training class. If applicable, costs for travel, lodging and meals will be the responsibility of the Owner.

C. Extent of Training:

1. Base extent of training on scope and complexity of BAS system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:
    a. Provide not less than 16 hours of training total.
    b. Stagger training over multiple training classes to accommodate Owner's requirements. All training to occur before end of warranty period.
    c. Break down total days of training into not more than four separate training classes.

D. Training Schedule:

1. Schedule training with Owner 20 business days, four weeks minimum, before expected Substantial Completion.
2. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with morning sessions and afternoon sessions as required. Training, including breaks and excluding lunch period, are not to exceed eight hours per day.
3. Provide staggered training schedule as requested by Owner’s Representative.

E. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number, and email address.
2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session. Indicate which attendees, if any, joined for only part of the training.

F. Training Attendee Headcount:

1. Plan in advance of training for a minimum of two to four attendees.
2. Make allowance for Owner to add up to two attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

G. Attendee Training Manuals:
   1. Provide each attendee with all training materials and visual presentations in electronic format.

H. Instructor Requirements:
   1. One or multiple qualified instructors, as required, to provide training.
   2. Instructors must have a minimum of five years of instructional training and BAS system experience on not less than five past projects with similar BAS system scope and complexity to BAS system installed.

I. Organization of Training Sessions:
   1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
      a. Daily operators.
      b. Advanced operators.
      c. System managers and administrators.
   2. Plan and organize training sessions to group training content to protect BAS system security. Some attendees may be restricted to some training sessions to ensure BAS system security.

J. Training Outline:
   1. Submit training outline for review by Owner's Representative at least ten (10) business days before scheduling training.
   2. Include in outline a detailed agenda for each training day that is broken down into each training session, training objectives for each training session, and synopses for each lesson planned.

K. On-Site Training:
   1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
   2. Provide training materials, projector, and other audiovisual equipment used in training.
   3. Provide as much of training located on-site as deemed feasible and practical by Owner.
   4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
   5. Use operator workstation that is to be used with BAS system in the training. If operator workstations are unavailable, provide temporary workstation to convey training content.

L. Off-Site Training:
   1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power, and data connectivity for each attendee.
   2. Provide capability to remotely access to Project BAS system for use in training where feasible.
   3. Provide operator workstation for use by each attendee.

M. Training Content for Daily Operators as Appropriate for Installed BAS System:
   1. Basic operation of system.
   2. Understanding BAS system architecture and configuration.
   3. Understanding each unique product type installed including performance and service requirements for each.
   4. Understanding operation of each system and equipment controlled by BAS system including sequences of operation, each unique control algorithm, and each unique optimization routine.
   5. Operating operator workstations, printers, and other peripherals.
   6. Logging on and off system.
   7. Accessing graphics, reports, and alarms.
   8. Adjusting and changing set points and time schedules.

9. Recognizing BAS system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of BAS controllers and I/O hardware.
12. Accessing data from BAS controllers.
13. Operating portable operator workstations.
14. Review of BAS testing results to establish basic understanding of BAS system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating BAS system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by BAS system:
    a. Operation of HVAC equipment in normal-off, normal-on, and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
    b. For HVAC equipment with factory-installed software, show that integration into BAS system is able to communicate with BAS controllers or gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles, and other modes of operation indicated.
    d. Hardware interlocks and safeties function properly and BAS system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
    e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
    f. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
    g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

N. Training Content for Advanced Operators as Appropriate for Installed BAS System:
1. Making and changing workstation graphics.
2. Creating, deleting, and modifying alarms including annunciation and routing.
3. Creating, deleting, and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting, and modifying reports.
5. Creating, deleting, and modifying points.
6. Creating, deleting, and modifying programming including ability to edit control programs offline.
7. Creating, deleting, and modifying system graphics and other types of displays.

8. Adding BAS controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing BAS system checkout and diagnostic procedures.
11. Performing BAS controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring BAS system hardware including controllers, workstations, communication devices, and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing, and repairing hardware.
15. Adjusting, calibrating, and replacing BAS system components.

O. Training Content for System Managers and Administrators as Appropriate for Installed BAS System:

1. BAS system software maintenance and backups.
2. Uploading, downloading, and offline archiving of all BAS system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

P. Video of Training Sessions:

1. Provide digital video and audio recording of each training session. Create separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Owner with two copies of digital files on cloud and flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

**END OF SECTION**

# SECTION 23 09 00
# BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

## PART 1 GENERAL

### 1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 05 00 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

### 1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include but not necessarily be limited to the following:

1. Provide new direct digital Building Automation System (BAS) for the new building with all hardware, software, controller, devices, sensors, conduit, wiring, and labor as required to provide complete and operational systems.
2. Provide control components and sequences of operation to meet or exceed the minimum requirements of the local applicable energy code and building codes.

B. General Requirements

1. The work includes designing, providing and installing a complete and fully operable building automation system as described in this Section of the Specification and as shown on the contract construction drawings and shall be in accordance with rules, regulations and standards as required by the authorities having jurisdiction. Any alternations to the quantity or location of the control panels shall be coordinated with the Electrical Contractor and General Contractor prior to bidding. Any BAS changes after bidding must be coordinated with Electrical Contractor and General Contractor at no additional cost to Owner.
2. Submit shop drawings of the entire control system components fully coordinated with major equipment suppliers' requirements. Provide proposed programming logic sequences of control functions on each system.
3. Installation of control components other than valves, dampers and sensing wells as required for a complete and workable system.
4. This Contractor shall furnish, install and coordinate the interlock and control wiring as specified and/or required for a complete and workable control system.
5. Control dampers are specified and furnished in Section 23 31 13 of these specifications. Provide damper actuators, wiring and conduit as required to operate all dampers as shown.
6. Upon completion of the installation, data entry and programming, provide complete validation and adjustment of specified control system through period of testing and Owner’s acceptance. The control contractor shall perform a point-to-point check out of all newly installed points to verify point existence, proper end to end connection and correct SI units with the Owners Representative.
7. The entire program and sequence of operation with the final points list shall be verified by the Control Contractor, the Owner’s Representative, and signed by both parties. A copy of the final program, sequence of operation, and points list shall be submitted to the Engineer for approval and inclusion with the operation and maintenance manuals.
8. Owner training on operation of the control system.
9. One-year warranty on workmanship and materials.

10. Interlocking of electrical systems and motors as shown on Drawings, except where specifically shown on electrical drawings.
11. All parameters identified in the controls sequence shall be adjustable at the front-end by the end user.
12. Contractor shall establish, tune, and coordinate all delays, timers, PID loops, and alarm latching. All PID loops shall maintain stable operational performance.

**1.03 RELATED WORK IN OTHER SECTIONS**

A. Refer to Division 0 and Division 1 for related contractual requirements.

B. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.

C. Refer to Division 23 and the following sections for Mechanical or Electrical Provision.

1. Division 01 - Submittal Procedures
2. Division 01 - Commissioning
3. Section 23 05 00: Basic HVAC Materials and Methods
4. Section 23 05 93: Testing, Adjusting, and Balancing
5. Section 23 09 02: Variable Frequency Drives
6. Section 23 21 13: Hydronic Piping, Valves and Specialties
7. Section 23 21 23: Hydronic Pumps
8. Section 23 31 13: Air Distribution
9. Section 23 73 14: Dedicated Outside Air Handling Units
10. Section 23 74 13: Packaged HVAC Units (Up to 25 Tons)
11. Section 23 81 45: Split Heat Pump Units
13. Sections 237000 through 238999 equipment
14. Division 26 – Electrical Materials and Methods
15. Division 27 – Communications Systems
16. Division 28 – Electronic Safety and Security

D. Refer to Division 26 sections for Electrical Provisions. Sources of 120-volt electrical power as indicated on the electrical drawings and specifications for control system components furnished by this section. The controls contractor shall be responsible for all additional electrical distribution from these connection points to the control panels and other controls devices.

E. BAS contractor will furnish, but not install the following:

1. Air flow measuring stations: furnish to mechanical installer and coordinate per manufacturer's requirements.
2. Flow meters: furnish to mechanical installer and coordinate per manufacturer's requirements.
3. Flow switches: furnish to mechanical installer and coordinate per manufacturer's requirements.
4. Hydronic pressure and temperature sensor wells: furnish to mechanical installer and coordinate per manufacturer's requirements.
5. Control valves: furnish to mechanical installer and coordinate per manufacturer's requirements.

**1.04 DEFINITIONS**

A. ASHRAE: American Society of Heating, Refrigerating, and Air-conditioning Engineers

B. BACnet: BACnet is a preferred communications protocol for building automation and control networks. It is an ASHRAE, ANSI, and ISO standard protocol. BACnet MS/TP is utilized with EIA/RS 485 hardware and BACnet/IP with Ethernet.

C. BAS: A system that optimizes the start-up and performance of HVAC equipment and alarm systems. A BAS greatly increases the interaction between the mechanical subsystems of a building, improves occupant comfort, lowers energy use, and allows off-site building control.

D. Modbus: One of industry standard communication protocols supported by NTMC. Developed by Modicon, Inc., North Andover, MA.

E. ODVA™: (Open DeviceNet Vendors Association) An international organization that supports computing network technologies based upon the Common Industrial Protocol (CIP). These include DeviceNet, EtherNet/IP, CIP Safety and CIP Sync.

F. RTD: Resistance temperature detector is a sensor whose resistance changes with temperature.

G. SCADA System (Supervisory Control And Data Acquisition): A type of industrial control system; a computer system which monitors and controls industrial, infrastructure, or facility-based processes.

H. Transducer: A device that converts variations in a physical quantity, such as pressure or brightness, into an electrical signal, or vice versa.

I. Transmitter: A set of equipment used to generate and transmit electromagnetic waves carrying messages or signals.

**1.05 REFERENCE STANDARDS**

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. ASHRAE Guideline 36-High Performance Sequences of Operation of HVAC Systems
2. ANSI/ASHRAE Standard 135, BACnet.
3. International Building Code (IBC), including local State and Local amendments.
4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
5. National Electrical Code (NEC).
6. FCC Part 15, Subpart J, Class A.
7. EMC Directive 89/336/EEC (European CE Mark).
8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

**1.06 GENERAL REQUIREMENTS**

A. Furnish a distributed logic BACnet-based control system including the operator’s workstation. The operator’s workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2016, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system’s functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

B. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

C. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

D. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

E. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices. All Ethernet and structured cabling must be installed and tested per ANSI/TIA-568-D (latest revision) and any other applicable standards.

F. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

G. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

H. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

I. Provide a comprehensive operator and technician training program as described herein.

J. Provide as-built documentation, operator's terminal software, a software key for a minimum of one additional computer (coordinate with Owner's Representative if additional keys are required), diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

K. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

## 1.07 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2016, BACnet and achieved listing under the BACnet Testing Laboratories BACnet. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. The Building Automation System (BAS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. All application controllers for every piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet LAN.

E. Room sensors shall be provided with digital readout that allow the user to view room temperature, CO2 or relative humidity, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

## 1.08 QUALITY ASSURANCE

A. The BAS shall be designed, installed, commissioned, and serviced by contractor authorized and trained personnel. System provider shall have an in-place support facility within two (2) hours response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.

B. The manufacturer and installer shall have a minimum of 5 years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. A list of successful past projects of similar type, size and complexity shall be submitted. In addition, a reference list of names, addresses and telephone numbers of the design Engineer and the Owner's Representative for each installation shall be provided. The references may be contacted and questioned about the timely delivery, installation, operation and service received for each installation.

C. The contractor shall provide experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.

D. The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

E. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.

F. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

H. Control system shall be engineered, programmed and supported completely by representative's local office that must be within 100 miles of project site.

I. Control components shall be products of the same manufacturer only, unless indicated otherwise and approved by Owner's Representative. Example – all valves shall by one manufacturer and all temperature sensors shall be by one manufacturer.

## 1.09 SUBMITTALS

A. Drawings

1. The system supplier shall submit point-to-point engineered drawings, control sequence, and bill of materials for approval.
2. Drawings shall be submitted in electronic format.

B. System Documentation

1. Include the following in submittal package:
    a. System configuration diagrams in simplified block format.
    b. All input/output object listings and an alarm point summary listing.
    c. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
    d. Complete bill of materials, valve schedule with Cv, valve pressure drop at design flow, and damper schedule.
    e. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.

f. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
g. For all system elements—operator's workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2016.
h. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.
i. A list of all functions available and a sample of function block programming that shall be part of delivered system.
j. Cut sheets of all equipment and components to be used as part of the BAS system.
k. Complete list of all available read/write points from integrated equipment controllers for review by Engineer.

C. Project Management

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

**1.010 WARRANTY**

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 05 00 for additional warranty and Substantial Completion requirements.

C. Warrant work as follows:

1. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Warrant all actuators for a period of five (5) years.
3. Respond during normal business hours within 24 hours of Owner's warranty service request.
4. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
5. If Owner determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Owner will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
6. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
7. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

D. Occupancy sensors: 5-year manufacturer warranty.

## PART 2 PRODUCTS

**2.01 MANUFACTURERS**

A. Acceptable BAS Manufacturers include:

1. Schneider Electric

## 2.02 WEB INTERFACE

A. General

1. BAS supplier shall provide Web-based access to the system as part of standard installation. User must be able to access all displays of real-time data that are part of the BAS using a standard Web browser. Web browser shall tie into the network through Owner-supplied Ethernet network connection. Web page host may be a separate device that resides on the BAS BACnet network, but is not the BAS server for the control system. BAS server may be a separate computer from the Web page host device. The Web page software shall not require a per-user licensing fee or annual fees. The Web page host must be able to support simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

B. Browser Technology

1. No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable and the webpage host shall directly access real-time data from the BAS BACnet network. Data shall be displayed in real-time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.

C. Communications

1. Web page host shall support Ethernet network connections. A network connection shall be used to gather real-time data from all the BACnet devices that form the BAS. This network shall communicate using BACnet, allowing the Web page host to gather data directly from units on the local LAN or from other projects connected over a WAN. This network shall also provide the connection to the BAS server for Web page generation.
2. An Ethernet connection shall provide the physical connection to the Internet or an IP-based WAN. It shall be the port that is used for the browser to receive Web pages and data from the Web page host. The Web page host shall act as a physical barrier between the BAS network and the WAN or Internet connection that allows the browser to receive Web pages and data. The two separate network connections provide for a physical barrier to prevent raw BACnet traffic being exposed on the IP network.
3. The Web page host shall provide for complete isolation of the IP and BACnet networks by not routing networking packets between the two networks.

D. Display of Data

1. Web page graphics shown on browser shall be replicas of the BAS displays. User shall need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays shall include animation just as BAS displays. Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.
2. Real-time data shall be shown on all browser Web pages. This data must be directly gathered using the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
3. It shall be possible for user from browser Web page to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.
4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

E. Time Schedule Adjustment

1. Web access shall allow user to view and edit all schedules in the system. This includes three types of schedules: standard, holiday and event. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.
2. Display of all three schedule types must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

F. Logging of Information

1. User shall use standard browser technology to view all trend logs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust Y axis of data viewed in graphical format. User shall also be able to download data through the Web interface to local computer. Data shall be in CSV format.

G. Alarm Handling

1. Web interface shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user-selected time frame. In addition, those alarms may be filtered for viewing per user-selected options. A single selection shall display all alarms that have not been acknowledged.

H. Web Page Generation

1. Web pages shall be automatically generated from the BAS displays that reside on the BAS server. User shall access Web page host through the network and shall initiate a Web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access using any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.

I. Password Security and Activity Log

1. Access through Web browser shall utilize the same hierarchical security scheme as BAS system. User shall be asked to log on once the browser makes connection to Web page host. Once the user logs in, any and all changes that are made shall be tracked by the BAS system. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged in to the system, regardless of whether those changes were made using a browser or through the BAS workstation.

J. BACnet Communication

1. Web server shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

## 2.03 BUILDING NETWORK CONTROLLER

A. Building Network Controller

1. BACnet Conformance

a. Building Network Controller shall be approved by the BACnet Testing Laboratories as meeting the BACnet Building Controller requirements.

B. Building network controller modules shall provide normal 7-day scheduling, holiday scheduling and event scheduling.

1. Logging Capabilities

a. Logs shall be supported in the building network controller. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
b. Logs may be viewed both on-site or off-site using WAN or remote communication.
c. Building network controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.
d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

2. Alarm Generation

a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
b. Each alarm may be dialed out as noted elsewhere.
c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
d. Controller must be store alarms as BACnet event enrollment objects, with system destination and actions individually configurable.

3. Demand Limiting

a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
b. Load shedding programs in building controller modules shall operate as coordinated with local utility.

4. Tenant Activity Logging

a. Tenant activity logging shall be supported by building network controller module.

C. BACnet/IP

1. This module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
2. All communication with operator's workstation, all application controllers and any other network hosts, shall be through BACnet/IP using standard ISO network layer 2 and layer 3 conventions and protocols.
3. All network cabling shall be installed and tested per ANSI/TIA-568-D (latest version). Only star type cabling configurations (each host connected to a dedicated switch port) is acceptable. Network hubs are not acceptable.
4. For categorized copper cabling (CAT5e, 6, and above) the maximum permalink length is 90 meters with an additional 10 meters allowed for patching and work space.
5. All communications as a minimum, must be configured to Fast Ethernet (100 megabits/second) or faster.
6. For IOT and IIOT devices, PoE (IEEE 802.3af), PoE+ (IEEE 802.3at), and PoE++ (IEEE 802.3bt type 1 & type 2) are acceptable when supported by a PoE rated switch or midspan injector.

D. MS/TP Module

1. MS/TP module shall support every listed function in this specification and the following.
2. Building controller MS/TP module communications shall be though BACnet MS/TP ASNI/EIA/RS-485-A LAN to all advanced application and application-specific controllers. Configure data rates to the maximum reliable settings (minimum bit-error rates) possible. ANSI/EIA/RS-422 & 232 based systems are not allowed.

E. Other BACnet Media

1. Although the BACnet standard supports other media types and configurations (Ethernet, ARCNET, P2P, LonTalk and Zigbee) these implementations are not considered authorized unless previously approved by the owner and engineer of record.

F. Power Supply Module

1. Input for power shall accept between 17–30VAC, 47–65Hz.
2. Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of all data in flash memory and for continuous operation of real-time clocks for minimum of 20 days.

G. Modbus Module

1. Modbus Module shall support every function as listed in this specification.
2. Building Controller Modbus module communications shall be ANSI/EIA/RS-485 only. Modbus module shall convert Modbus data into BACnet objects. Modbus module shall also route messages to Ethernet-MS/TP module for BACnet Ethernet communication over WAN.
    a. Modbus Module shall support ASCII or RTU Modbus communication at 9600 or 4800 baud.
    b. EIA-485 connection shall support connections of up to 247 Modbus units.
3. BACnet Translation
    a. All Modbus data shall be translated into BACnet objects by the Modbus module. All configuration tools shall be supplied to assure data is translated as necessary to the correct format and value.
    b. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

## 2.04 APPLICATION CONTROLLERS – GENERAL

A. All application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

B. All program sequences shall be stored on board controller in memory. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller ten(10) times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

C. Provide all application controllers with a minimum of 10% spare points for analog input, analog output, digital input and digital output signals.

## 2.05 APPLICATION CONTROLLERS –AIR HANDLER OR CENTRAL PLANT

A. Provide one or more native BACnet application controllers to adequately cover all objects listed in object list. All controllers shall interface to the building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. The programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

C. Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

D. Schedules

1. The controller shall support a minimum of three (3) BACnet Schedule Objects and have a real-time clock on board with battery backup to maintain time through a power loss.

E. Logging Capabilities

1. Controller shall support a minimum of 50 trend logs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

F. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

G. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

## 2.06 APPLICATION CONTROLLER – UNITARY MECHANICAL EQUIPMENT

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

## 2.07 AUXILIARY CONTROL DEVICES

A. Temperature Sensors (TS)

1. Duct air temperature (duct mounted, indoor location)
    a. Thermistor type with 1/4" stainless steel probe and junction box. 10K ohm, type II, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend 25% (minimum) to 50% (maximum) into the width of duct. Manufacturer: Veris #TF Series, Dwyer Instruments #TE-DFG Series, Kele (Minco) #TT Series.
2. Duct air temperature (duct mounted, outdoor location)
    a. Thermistor type with 1/4" stainless steel probe and weather-tight junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend 25% (minimum) to 50% (maximum) into the width of duct. Manufacturer: Veris #TG Series, Dwyer Instruments #TE-DFW Series, Kele (Minco) #TT Series.
3. Outside air temperature (wall mounted location)
    a. Thermistor type with stainless steel or platinum probe and weather-proof aluminum junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe encased in durable radiation shield with radiation solar shield. Manufacturer: Veris #TO Series, Dwyer Instruments #TE Series.
4. Pipe or tank fluid temperature (immersion probe)
    a. Immersion probe type temperature sensor encased in a corrosion-resistant stainless steel thermowell. Thermistor type with metallic housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Manufacturer: Veris #TIG Series, Dwyer Instruments #TE Series.
5. Temperature averaging (coil mounting)
    a. Thermistor type with bendable copper tubing element water-resistant junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend across coil face at least twice to cover two corners and one midpoint. Mounting of tubing shall utilize Veris #AA64 mounting clips. Manufacturer: Veris #TA Series, Kele #ACI Series.

B. Intelligent Room Temperature Sensor (TS) with LCD Readout
1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit and allow occupant to raise and lower setpoint, and activate terminal unit for override use-all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
2. The intelligent room sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in degrees Fahrenheit or Centigrade.
3. Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.
4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list. Field service mode shall be customizable to fit different applications. If intelligent room

sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

C. Humidity Sensors
   1. Indoor space humidity (wall mounted inside):
      a. 1% accuracy thin film capacitive replaceable sensor element, LED display. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HW Series, Dwyer Instruments #RHP-W Series.
   2. Outside air humidity (wall mounted outdoors):
      a. 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HO Series, Dwyer Instruments #RHP-W Series.
   3. Duct air humidity (duct mounted indoor application):
      a. Humidity sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HD Series, Dwyer Instruments #RHP-W Series.
   4. Indoor space humidity with temperature (wall mounted inside):
      a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, LED display, push button override and setpoint slider. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HW Series, Dwyer Instruments #RHP-W Series, Vaisala #HMW Series.
   5. Outside air humidity with temperature (wall mounted outside):
      a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HO Series, Dwyer Instruments #RHP Series, Vaisala #HMS Series.
   6. Duct air humidity and temperature (duct mounted indoor application):
      a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HD Series, Dwyer Instruments #RHP Series, Vaisala, #HMT Series.
   7. Duct high limit humidity switch (duct mounted indoor application):
      a. Single-stage duct hygrostat with insertion probe to monitor humidity level with NO and NC contacts. Adjustable relative humidity setpoint range of 35 to 100% RH. SPDT 250 Vac/ 15 amp.
      b. Manufacturers: Honeywell #H6045A1002.

D. CO2 Sensors
   1. Indoor space measurement (wall mounted):
      a. Non-dispersive infrared sensor in high impact white ABS plastic enclosure. Input power 20 to 30 VDC/24 AC, 100 mA. Analog output 4-20 mA. Operating range 32°F to 122°F (0°C to 50°C). Measurement range of 0-2000 ppm with accuracy of +/- 30 ppm.
      b. Manufacturers: Veris #CWE Series, Dwyer #CDT Series.

2. Outdoor air measurement (indoor duct mounted location):
    a. Non-dispersive infrared sensor in high impact white ABS plastic enclosure. Input power 20 to 30 VDC/24 AC, 100 mA. Analog output 4-20 mA. Operating range 32°F to 122°F (0°C to 50°C). Measurement range of 0-2000 ppm with accuracy of +/- 30 ppm.
    b. Manufacturers: Veris #CDE Series, Dwyer #CDT Series.

E. CO2, Humidity, Temperature Combined Sensor (Indoor Wall and Duct Mounted)
1. High impact white ABS plastic enclosure with digital LCD display and adjustable setpoints.
2. Input power 20 to 30 VDC/24 AC, 100 mA.
3. Analog output 4-20 mA.
4. Operating range 32°F to 122°F (0°C to 50°C).
5. CO2 Sensor: Non-dispersive infrared sensor in. Measurement range of 0-5000 ppm with accuracy of +/- 30 ppm.
6. Humidity Sensor: Digitally profiled thin-film capacitive, plus or minus 2% RH. 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
7. Temperature Sensor: Thermistor. 2% accuracy thin film capacitive replaceable sensor element.
8. Manufacturers: Veris #CWLP Series.

F. Occupancy Sensor
1. Low-profile, dual technology sensor with 360 degree detection. UL and cUL listed.
2. Construction:
    a. Dual-element, temperature-compensated pyroelectric sensor
3. Features:
    a. Immunity to RFI and EMI to eliminate false triggers.
    b. Time delay adjustment from 30 seconds to 30 minutes.
    c. Two levels of sensitivity, adjustable with physical switch.
    d. Isolated relay with normally open and normally closed outputs, rated 1A @ 24VDC/VAC.
    e. 24VAC/VDC voltage +/- 10%.
    f. Mounting hardware for ceiling tile or gypsum board with mud ring.
4. Manufacturers: Wattstopper (Legrand) #CI-24.

G. Leak Detector
1. Water leak detector connected to BAS to alarm on detecting the presence of water in the following locations:
    a. Secondary condensate drip pan below air conditioning air handling units and fan coils located above spaces with electrical and/or electronic equipment.
    b. Below raised access floors with one sensor per 5,000 square feet (maximum) where water pipes are located below access floor. Or, one sensor per 10,000 square feet (maximum) where no water pipes are located below access floor.
    c. On the floor adjacent to sump pump(s).
    d. On the floor of mechanical rooms adjacent to electrical equipment and/or data/electronics equipment rooms. Single point leak detector for locating in condensate drip pan below air conditioning air handling units, under raised floors, in secondary drain pans, on the floor near a sump pump, and in other critical drain locations. Sensing of water shall provide an alarm and send a signal to the BAS or thermostat to shut down operation of the air conditioning compressors.
2. Features:

a. Mounting: Base mounted.
b. Service: water of conductive fluids.
c. Sensing gap: Minimum 1/8" (3 mm) to maximum 1/4" (6 mm).
d. Switch type: DPDT relay.
e. External power: 1 A @ 24 VAC/DC.
f. Audible alarm: 85 dB @ 1' distance (0.3 m).
g. Visual indicators:
    1) Green to indicate power is supplied.
    2) Red to indicate water is detected.
h. Temperature limits: 32 to 122°F (0 to 50°C).
i. Flammability: plenum rated electrical cable with length as required and UL-94 compliant housing.
j. Attached with 1/16" thick double sided adhesive urethane foam tape.

3. Manufacturers: Dwyer #WD3-LP-D2-A, Kele, Veris.

H. Condensate Sensor (Pipe):
1. Solid state condensate detector for locating condensate on chilled water piping. Sensing of water shall provide a signal to the BAS system for control sequence adjustment to raise chilled water temperature.
2. Features:
    a. Service: mounted on metallic pipe from 1/2" to 3" in diameter.
    b. Sensing: 80% to 90% RH (adjustable) surface moisture.
    c. Switch type: SPST open/close.
    d. External power: 40 mA at 24 VAC or 20 mA at 12 to 30 VDC.
    e. Temperature limits: 149°F (65°C).
    f. Flammability: plenum rated electrical cable with length as required and UL-94 compliant housing.
    g. Mounting bracket with stainless steel worm gear clamp for attachment.
3. Manufacturers: Consense #CG-ICM-P.

I. Differential Pressure Transmitters:
1. Duct Static Pressure Transmitter:
    a. Differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero, LCD display.
    b. Manufacturers: Veris #PX Series, Dwyer Instruments #MS2, Kele #DPA Series.
2. Building Static Pressure Transmitter:
    a. Differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero. Provide with AA05 ceiling mount static pressure pick up, LCD display.
    b. Manufacturers: Veris #PX Series, Dwyer Instruments #MS2, Kele #DPA Series.
3. Water differential pressure transmitter:
    a. Differential pressure transmitter, wet/wet, switch selectable pressure ranges, jumper selectable port swap, LCD display and NEMA 4 enclosure.
    b. Manufacturers: Veris #PW Series, Dwyer Instruments #MS2.

J. Differential Pressure Switches:
1. Filter differential pressure switch for status:

a. Adjustable differential pressure switch, dual scale adjustable knob, silicone diaphragm, single-pole double-throw type, 1/4" tubing diameter, setting range from 0.08 in. w.c. (20 Pa) up to 20 in. w.c. (5000 Pa), and NEMA-3 enclosure.
b. Manufacturers: Dwyer #ADPS Series.

2. Duct static manual reset high pressure safety switch for supply fan shut down:
   a. Adjustable trip and manual reset, single-pole double-throw, 120-480 VAC. Maximum operating range of -30°F to 180°F (-34°C to 82.2°C) and humidity limit of 80% RH non-condensing. Provide weatherproof housing where mounted outdoors. Adjustable setpoint between 3.0 to 11.75 in. w.c.
   b. Manufacturers: Dwyer #1900-10-MR Series.
3. Duct static manual reset high pressure safety switch for return fan shut down:
   a. Adjustable trip and manual reset, single-pole double-throw, 120-480 VAC. Maximum operating range of -30°F to 180°F (-34°C to 82.2°C) and humidity limit of 80% RH non-condensing. Provide weatherproof housing where mounted outdoors. Adjustable setpoint between 1.40 to 5.5 in. w.c.
   b. Manufacturers: Dwyer #1900-5-MR Series.

K. Air Filter Differential Pressure Gauges: (where not supplied by air handling equipment manufacturer):
1. Dial type, diaphragm-actuated with external zero adjustment and 3-7/8-inch diameter dial.
2. With two (2) static pressure tips, 2-way valves, tubing and mounting plate (and adjustable signal flag).
3. Range as recommended by filter manufacturer.
4. One gauge per filter bank for direct field verification independent of BAS monitoring.
5. Manufacturers: Dwyer 2000 Series Magnehelic.

L. Current Sensors
1. Current sensing switch for constant speed fans and pumps to detect belt loss, coupling shear and mechanical failure:
   a. Current switch with split core, adjustable trip, pilot light, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #HX08 Series.
2. Current sensing switch for VFD controlling multiple fans and pumps:
   a. VFD current switch split core, self-learning adjustable trip, pilot light, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #H614.
3. Current sensing switch with fixed trip point for monitoring constant speed direct-drive fans, recirculating pumps or other fixed loads:
   a. Current switch with split core, fixed trip, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #HX00 Series.
4. Current sensing switch with fixed trip point for monitoring constant speed EC motor fans, recirculating pumps or other fixed loads:
   a. Current switch with split core, fixed trip, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #H6ECM05 Series.
5. Current sensing transmitter for load trending with proportional 4 to 20 mA output signal:

a. Current sensing transmitter with self-gripping split core, preset slide switches, and removable mounting bracket.
b. Manufacturers: Veris #H921.

6. Current sensing transmitter with relay for fan start/stop control and status monitoring of motors:
   a. Current sensing transmitter with integral relay, slide switches, self-gripping split core, and removable mounting bracket.
   b. Manufacturers: Veris #H931.

M. Flow Meters – Liquid:

1. Single turbine insertion flow meter:
   a. 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple, and branch outlet. Provide with D-100 totalizing display module with BACnet interface.
   b. Manufacturers: Onicon #F-1100, Badger Meter #Impeller SDI Series.
2. Electromagnetic inline flow meter for high accuracy flow measurement of clean fluid in a closed loop:
   a. Accuracy: +/- 0.25% with bidirectional flow capability. Maintain minimum of three (3X) straight pipe diameters upstream and two (2X) pipe diameters downstream when installed greater than seven (7X) pipe diameters downstream of a pump.
   b. Electrodes: Two electrodes for flow measurement, one electrode for empty pipe detection, and one electrode for grounding as required by piping system. Constructed of Hastelloy C22, 316 stainless steel, gold, platinum or tantalum.
   c. Pipe spool: 316 stainless steel.
   d. Flanges: ANSI B16.5 carbon steel, 304 or 316 stainless steel.
   e. Housing: NEMA 4X weather tight aluminum enclosure, or carbon steel or stainless steel. Powder coated.
   f. Power: 120 VAC or 24 VDC.
   g. Connections: Four programmable digital outputs (minimum), one analog programmable and scalable output, and one digital input.
   h. Totalizing display: Backlit with minimum four rows of text with BACnet interface.
   i. Ambient operating temperature range: -4°F to 140°F (-20°C to 60°C).
   j. Fluid temperature to maximum of 212°F (100°C).
   k. Manufacturers: Badger Meter #ModMAG M2000, Onicon #FT-3000.
3. Ultrasonic clamp-on flow meter (for metal piping installation only):
   a. Accuracy: +/- 1% with bidirectional flow capability. Maintain minimum of ten (10X) straight pipe diameters upstream and five (5X) pipe diameters downstream when installed greater than 24 pipe diameters downstream of a pump, header or valve.
   b. Transducers: Two ultrasonic transducers function as both transmitters and receivers. Volumetric flow measurement is made by measuring the difference time between two digitally synthesized contra propagating acoustic waves traveling between the two ultrasonic transducers positioned lineally, a known distance apart, on the outside of a closed pipe.
   c. Housing: NEMA 4 or 4X weather tight aluminum enclosure.
   d. Transducer housing: PVC, CPVC, PTFE or PBT glass filled as required by fluid operating temperature.
   e. Power: 120 VAC or 24 VDC.
   f. Connections: Two programmable digital outputs (minimum), one digital input, and one 4-20 mA output.
   g. Totalizing display: Backlit with minimum four rows of text with BACnet interface.

h. Ambient operating temperature range: -4°F to 140°F (-20°C to 60°C).
i. Fluid temperature to maximum of 212°F (100°C).
j. Flow meter may also be used with energy meter.
k. Manufacturers: Badger #Dynasonics TFX-5000, Siemens #Sitrans FS230.

4. Electromagnetic insertion meter for medium accuracy flow measurement of a clean fluid in a closed loop:
   a. Insertion type Electromagnetic.
   b. Accuracy: +/- 1%. Maintain minimum of ten (10X) straight pipe diameters upstream and five (5X) pipe diameters downstream when installed greater than 30 pipe diameters downstream of a header or valve.
   c. Sensor: Stainless steel with empty pipe signal.
   d. Power: 24 VDC.
   e. Connections: One digital output and one 4-20 mA output.
   f. Ambient operating temperature range: 32°F to 140°F (0°C to 60°C).
   g. Fluid temperature to maximum of 212°F (100°C).
   h. Flow meter may also be used with energy meter.
   i. Manufacturers: Onicon F-3500.

N. Flow Meters - Natural Gas:
   1. Thermal mass flow meter, in-line or flanged. Provide with totalizing display module with BACnet interface.
   2. Manufacturers: Onicon #F-5100 Series, Badger Meter #VN-2000.

O. BTU Meters:
   1. BTU meter with BACnet interface with matched temperature sensors and thermo-wells, NEMA 4X wall mount enclosure, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple, and branch outlet.
   2. Manufacturers: Onicon #System-10 and provide with Onicon #F-1100 single turbine insertion flow meter, or Onicon #F-3500 electromagnetic flow meter, or equal by E-Mon D-Mon or Badger.

P. Airflow Measuring Arrays
   1. Provide one thermal dispersion airflow/temperature measurement device (ATMD) at each location indicated on the plans, schedules and/or control schematics.
   2. Each ATMD shall consist of one to four sensor probes and a single, remote transmitter. Each sensor probe shall consist of one to eight independent sensor nodes in a gold anodized, aluminum 6063 alloy tube with 304 stainless steel mounting brackets.
   3. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Chip thermistors of any type or packaging are not acceptable.
   4. The velocity-weighted average temperature output performance of the ATMD is preferred to that of the specified temperature measuring device (TMD), when the location of the ATMD and TMD are effectively the same.
   5. Outside Air Measurement:
      a. Provide a minimum outside airflow measuring station in a straight duct section upstream from the minimum outside air dampers and interfacing control for providing an electronic signal for use by the control contractor in controlling a minimum outside airflow. On outdoor mounted air handling units, outside airflow measurement station is to be factory mounted on the intake side of the outside air intake (upstream of the damper).
   6. Sensor Performance:
      a. Fan Installation:

1) Installed airflow accuracy: +/- 3% to 10% of reading with +/- 0.25% repeatability.
2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, +/- 0.15°F temperature accuracy.

b. Outside Air/duct Installation:

1) Installed airflow accuracy: +/- 2% of reading with +/- 0.25% repeatability.
2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, +/- 0.15°F temperature accuracy.

7. Transmitter:

a. Flow measuring array to include a transmitter for flow and temperature analog output signal for the building energy management system to be user selectable in either 4-20 mA or 0-10VDC. Coordinate signal output with controls installer.
b. Transmitter to include an analog airflow gauge to provide direct analog readout in cfm. Mount on the outside of the air handler if air handler is located in a mechanical room. Mount in a NEMA 3R control cabinet if located outside.
c. Device to provide switch selectable Modbus or Johnson N2 outputs.
d. Device to be UL listed.
e. The transmitter shall be powered by 24 VAC, shall include over-voltage and over-current protection, and shall include watchdog circuitry to ensure continuous operation following power failures and/or brown- outs.
f. The transmitter shall determine the airflow rate and temperature of each sensing node prior to averaging.
g. The transmitter shall include self-diagnostics and other features to ensure reliability and continued operation despite a limited failure. The transmitter shall automatically detect sensor damage and correctly calculate the average using the remaining functional sensor nodes, while reporting a system fault over the network and by local visual indication.
h. All integrated circuits shall be industrial rated for operation down to -40°F (-40°C).
i. The environmental operating temperature limits for the transmitter shall be -20°F to 120°F (-29°C to 49°C).
j. The system shall be factory tested prior to shipment and not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines.
k. The Sensors shall be calibrated to NIST traceable standards.

8. Manufacturers: Ebtron, Paragon Controls, Dynasonics.

Q. LED Pilot Lights

1. Provide wall mounted pilot lights to indicate when operable windows may be opened or closed based on outdoor weather conditions as determined by BAS. Mount adjacent to main access door serving space with operable windows or adjacent to light switch, as shown on Architectural or Mechanical drawings. Coordinate final placement of pilot lights and color of cover plate with Owner's Representative.
2. Polycarbonate or steel wall box.
3. Wall plate color to match wall color. Color options shall include: ivory, white, black or stainless steel.
4. Continuous color indication. LED lights, 20-25 mm diameter. One green light located above one red light.
5. Voltage as selected by BAS installer, 12-volt or 24-volt, 20 mA, maximum.
6. Manufacturers: Signaworks #WP22 Series.

R. Flow Switch

1. Paddle type vane flow switch for insertion into pipe sizes 1" to 8". Forged brass body, stainless steel vane, and tin-bronze bellows. Maximum operating temperature to 230°F (110°C) and maximum operating pressure to 145 psig (10 bar). NEMA 4 enclosure, SPDT snap switch, 250 VAC (max). Connection using 1" male NPT or BSPT. Switch must be installed vertically on a horizontal pipe run.
2. Manufacturers: Dwyer #FS-2.

**2.08 ACTUATORS**

A. Electronic Actuators:

1. Size for torque required for damper seal at load conditions.
2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
3. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
4. Overload protected electronically throughout rotation.
5. Fail-Safe Operation: Mechanical, spring-return mechanism
6. Electronic Fail-Safe Operation: Incorporate a visual indication of the fail safe status on the face of the actuator. The power fail position shall be field adjustable between 0 to 100% in 10% increments. The electronic fail safe shall have a 2-10 second adjustable operational delay.
7. Power Requirements (Spring Return): 24-V ac, maximum 10 VA at 24-V ac or 8 W at 24-V dc (running). Maximum 1 VA at 24-V ac or 1 W at 24-V dc (holding).
8. Proportional Actuators shall be fully programmable through an onboard EEPROM by using an external cable and software interface.
9. Temperature Rating: -22 to +122ºF.
10. Housing: Minimum requirement NEMA type 2 mounted in any orientation. .
11. Agency Listings: ISO 9001, cULus, CE or CSA
12. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
13. Manufacturers: Belimo, Siemens, Honeywell, Keystone #777.

B. Actuators with torque requirements exceeding 360 inch-pounds:

1. The combination of valve and actuator shall meet the close-off requirements as specified in Section 2.16.H – Butterfly Valves.
2. Coupling: ISO 5211 mounting standards.
3. Overload Protection: A self-resetting thermal switch embedded in the motor.
4. Manual Override: Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the actuator in the event of an electrical power failure
5. Power Requirements: 24VAC, 120VAC, or 230VAC single phase.
6. Auxiliary Switches: 2 SPDT rated 3A at 250 VAC.
7. Temperature Rating: -22 to +122ºF.
8. Duty Cycle Rated 75% minimum.
9. Housing: Minimum requirement NEMA type 4X/ IP67 with an industrial quality coating. Actuator shall have an internal heater to prevent condensation within the housing. A visual indication beacon shall indicate position status of the device.
10. Agency Listing: ISO, CE, CSA
11. The manufacturer shall warrant for 2 years from the date of production.
12. Manufacturers: Belimo, Siemens, Honeywell.

**2.09 CONTROL VALVES**

A. Manufacturer: Belimo, Siemens, Honeywell.

B. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).

C. Control Valve Actuators:
   1. Size for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
   2. Coupling: directly couple and mount to valve stem, shaft ISO-style direct-coupled mounting pad.
   3. Non-spring return actuators shall have manual override
   4. Spring return actuators of 90 inch-pounds or above shall have manual override.

D. Control Valves:
   1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
   2. Sizing (Water):
      a. Two-Position: Line size or size using a pressure differential of 1 psi.
      b. Two-Way Modulating: Size for a pressure differential across the valve of 4 psi at design flow, or twice the load pressure drop at design flow.
      c. Three-Way Modulating: Size for a pressure differential across the valve of not more than 4 psi at design flow
   3. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system head pressure for two-way valves and 150 percent of the design pressure differential across the three-way valves.
   4. The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.

E. Pressure Independent Control Valves:
   1. NPS 2 and Smaller: Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc for equal percentage characteristic.
   2. NPS 2-1/2 through 6: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
   3. The control valve assembly shall have an integral magnetic flow meter Magnetic flow meter to accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSID across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
   4. Flow Characteristics: NPS 1/2” through 2” Equal percentage characteristic. NPS 2-1/2” through 6” capable of Equal percentage or Linear characteristic (field programmable).
   5. All proportional actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
   6. Actuators for 3-wire floating (tri-state) and on 2 position (on/off) on 1/2” to 1” pressure independent control valves shall fail in place.
   7. Water Coil optimization 2-1/2” through 6” shall be accomplished by utilizing an energy meter (a pressure independent control valve assembly) with two integral temperature sensors providing feedback of coil inlet and coil outlet water temperature; and integral magnetic flow meter for control and to provide actual analog flow feedback. Valve assembly to have built in intelligence to control pressure independently and a Delta T Manager mode to mitigate low delta T syndrome

by referencing an internally programmed design delta T setpoint. Valve assembly shall be capable of communicating data by means of BACnet MS/TP, BACnet I/P and TCP IP. Data to include, but not be limited to, inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr. Valve assembly shall be capable of trending and storing up to 13 months of data on the actuator. Trended data on actuator to be retrievable via TCP IP or direct connect and download to *.csv file format.

8. The manufacturer shall provide a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).
9. The control valve shall require no maintenance and shall not include replaceable cartridges.
10. NPS 2" and smaller pressure independent control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain an integrated isolation ball valve/manual air vent with strainer/shut-off valve/drain with pressure/temperature test ports. The return side shall contain a union fitting with a pressure/temperature test port, pressure independent control valve, and integrated isolation ball valve/manual air vent with a pressure/temperature test port. Shut-off valves as an integrated part of the pressure independent control valve are prohibited. A braided stainless flexible hose shall be provided for each coil supply and return connection for all pipe packages.

F. Characterized Control Valves:

1. NPS 1/2" and smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi WOG Water oil gas, chrome plated brass Stainless steel stem is an option ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
2. NPS 1" through 2": Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
3. NPS 2-1/2" through 6": GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
4. Flow Characteristics: Equal percentage characteristics.
5. Six-way control valve used for chilled beam applications shall have the following characteristics:
    a. NPS 1/2" and 3/4": Nickel plated forged brass body rated at no less than 600 psi, dual chrome plated brass ball and blowout proof stems, and female NPT end fittings. Each three-way portion of the 6-way valve body shall have EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
    b. The six-way control valve shall be controlled by a rotary actuator for managing two media in a modulating application. The valve shall be closed to all flow at mid-rotation.

G. Butterfly Valves – Resilient Seat:

1. NPS 2 to 12: Valve body shall be full lugged cast iron to meet ANSI 150 or 300 standards, with a 304/316/416 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. The shaft shall be supported at four locations by reinforced PTFE bushings.
2. NPS 14 and Larger: Valve body shall be full lugged cast or ductile iron to meet ANSI 150 or 300 standards, with a 304/316/416 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by reinforced PTFE bushings.

3. Sizing:
    a. Two-Position: Line size or size using a pressure differential of 1 psi.
    b. Modulating: 4 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position and a design velocity not to exceed 12 feet per second.
4. Close-Off Pressure Rating: NPS 2-12" 200 psi bubble tight shut-off. NPS 14 and larger, 150 psi bubble tight shut-off.

H. Butterfly Valves – High Performance:
1. Valve body shall be full lugged carbon steel body to meet ANSI Class 150 or 300 standards, as required, with a 316/416 stainless steel disc without a nylon coating, reinforced PTFE seat, and meet ANSI Class 150/300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed PTFE bushings. Valve packing shall be PTFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 2" insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.
2. Sizing:
    a. Two-Position: Line size or size using a pressure differential of 1 psi.
    b. Modulating: 4 psig, or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position with the design velocity less than 32 feet per second.
3. Flow Characteristics: Modified equal percentage, unidirectional.
4. Close-Off Pressure Rating: 150 psi bubble tight shut-off.
5. Media Temperature Range: ANSI Class 150 limitations.
6. Max Differential Pressure: 285 psi @ 100°F for ANSI 150 (725 psi @ 100°F for ANSI 300).

I. Equipment Isolation Valves:
1. Slow Closing/Quick Opening Solenoid Valve (2-Way/2-Position), 1/2" to 2-1/2":
    a. Class 125, brass body, stainless steel core, snubber slows disc closing to protect system against water hammer, minimum operating pressure differential 5 psi, 120 VAC input, normally closed (closed when deenergized). Lead-free construction and UL/NSF compliant. Valve shall full stroke close in 4 to 10 seconds and open immediately when energized. Manufacturers: Asco Redhat #8221.
2. Butterfly Valves, 2-1/2" and larger:
    a. Valve body shall be full lugged cast iron body and shall meet ANSI Class 125/150 flange standards. Disk shall be aluminum bronze or 304/316/416 stainless steel with EPDM seat and extended neck as required to accommodate insulation. The shaft shall be supported at four locations by reinforced PTFE bushings.
    b. Valve actuator with integrated linkage for 90° degree rotation and visual position indicator. Power supply with input voltage from 24 to 240 VAC. Power consumption in operation 20 watts and resting power consumption of 6 watts maximum. Adjustable running time of 30 to 120 seconds for full stroke. Ambient humidity to 95% RH non-condensing and operating temperature from -22°F to 122°F (-30°C to 50°C). Die cast aluminum Type 4X enclosure. Open/close or floating point operation as required by system operation. Manufacturer: Belimo #PR Series.

**2.010 ENERGY VALVE**

1. NPS 1/2" through 2":
    a. 2-way characterized control valve with tight close-off. Nickel-plated forged brass body rated at no less than 360 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and flow characterizing disc.
    b. Non-spring return or electronic fail-safe actuator with analog input and output
    c. Ultrasonic flow meter with temperature and glycol compensation.
    d. Supply and return temperature sensors with thermowells and pipe fittings.
2. NPS 2-1/2" through 6":
    a. 2-way characterized control valve with tight close-off. GG25 cast iron body according to ANSI Class 125 or Class 250 per system pressure class, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125/250 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
    b. Non-spring return or electronic fail-safe actuator with analog input and output
    c. Magnetic flow sensor.
    d. Supply temperature sensor with thermowell.
    e. Return temperature sensor embedded.

B. Manufacturer: Belimo.

**2.011 DOMESTIC WATER SECURITY VALVES**

A. Scope: connect to BAS for automatic opening and closing of domestic cold water supply to building.

B. Control Valve Actuator:

1. High torque actuator, fast opening and closing to control incoming domestic cold water service.
2. NEMA 6P waterproof enclosure.
3. UL listed.
4. Power supply input:100–240 volts, 60 Hz, 1 amp maximum. Output 18 volts, 2.22 amps.
5. BAS feedback signals for valve open or closed.
6. 12 VDC trigger contact to open valve.

C. Control Valve:

1. 316 stainless steel, 3-piece construction for body, ball and stem.
2. Equipped with a manual handle for emergency override.
3. Pressure rated to 600 psi, minimum.
4. Full port ball valve.
5. Threaded for sizes 1/2" to 2".

D. Low lead and certified for potable water use per UPC and NSF/ANSI 61.

E. Manufacturer: Automatic Security Valves.

**2.012 WIRELESS SYSTEM**

A. Architecture and Communications:

1. Wireless equipment controllers and control devices shall conform to IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems. Equipment shall also comply with the following standards:
    1) UL 916: Energy Management Equipment
    2) UL 94: The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating

3) UL 873: Temperature regulating and indicating equipment
4) ZigBee Building Automation
5) BACnet Tunneling

2. Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
3. Operating range shall be a minimum of 200 feet; open range shall be 2,500 ft. (762 m) with less than 2% packet error rate to ensure reliable operation.
4. To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
5. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
6. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15 .2 47 & Subpart E.
7. The system devices shall use direct sequence spread spectrum RF technology.
8. The system devices shall operate on the 2.4 GHZ ISM Band.
9. The system devices shall be FCC compliant to CFR Part 15 subpart B Class A.

B. Service Tools:

1. To support network setup and troubleshooting, service tools shall display link quality and hop quantities for each wireless device.
2. Wireless service tool access to communication link shall be provided to minimize installation and troubleshooting labor.

C. Construction:

1. Devices such as sensors, receivers and signal coordinators, intended to be installed in a return air plenum, shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB. Wall mounted devices may be assembled in NEMA-1 plastic enclosures.

D. Wireless Field Bus System:

1. The system shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for BACnet devices at multiple system levels. This includes communications from field controllers to sensors and from sensors to field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.
2. The field bus coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55 or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a coordinator for initiation and formation of the network
    a. The coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
    b. The coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).
    c. The coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.
3. A wireless field bus router shall be used with any controller and field device to provide a wireless interface to supervisory devices and associated wireless mesh room temperature sensors.
    a. The router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.

b. The router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
c. The router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.

E. Wireless Room Temperature Sensors:
1. Wireless space sensors shall be capable of continuous operation in the following conditions:
a. Ambient operating temperature range shall be 32°F to 122°F (0 to 50°C).
b. Ambient operating and storage humidity range shall be 5 to 95%, non-condensing.
2. Wireless room temperature sensors shall sense and transmit room temperatures, room set point, room occupancy notification low battery condition to an associated router.
a. The sensors shall be available with:
1) Warmer/cooler setpoint adjustment or no setpoint adjustment.
2) Setpoint adjustment scale: 55°F to 85º F (minimum range).
b. Wireless sensors shall be provided with display of room temperature, signal strength, fan mode, occupancy and network status as required by application and indicated on plans or in the schedules.
3. Features:
a. The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.
b. To check for proper operation, wireless space temperature sensors shall include signal strength on the space sensor display.
c. To support use by the physically impaired, the wireless space sensor shall be a minimum font size of 12 points, and the LCD model shall be readable in low light conditions.
d. An optional 2% relative humidity sensors module shall be available for humidity control applications to minimize the need for wired sensors, and shall not shorten typical battery life to less than 15 years.
e. Wireless space sensors shall be available as: temperature only, field configurable model with digital display, and optional 2% humidity module for use in either model above. The field configurable models shall all allow field configuration without a field service tool. Configuration options include: setpoint, override pushbuttons, fan speed, and system mode switches. System mode, fan speed and setpoint shall include a lock option. The digital display shall also be field configurable to display in Fahrenheit or Celsius units of measure, and can also be configured to display setpoint only.
f. The wireless space sensor addresses shall be held in non-volatile memory to ensure operation through system voltage disturbances and to minimize the risk of incorrect association.
g. The wireless space sensor shall be addressed using pushbuttons and display with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing.
h. The wireless space sensor shall include security screws to protect against theft.
4. Accuracy:
a. To ensure proper system performance, the wireless space sensors shall automatically determine when the space temperature is rapidly changing. When the space temperature is rapidly changing, the space temperature shall be transmitted at least once each 30 seconds. The maximum time between transmissions shall be 15 minutes. Space temperature sensing accuracy shall be +/- 0.5°F (+/- 0.28°C).

F. Wireless Communications Interface:
   1. Wireless communication devices and receivers shall be capable of continuous operation in the following conditions:
      a. Ambient operating temperature range shall be 32°F to 122°F (0 to 50°C).
      b. Ambient operating and storage humidity range shall be 5 to 95%, non-condensing.
   2. Features:
      a. Wireless communications interface shall be addressed using rotary switches with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing.

G. Many-To-One Wireless Receiver:
   1. The Many-To-One System Receiver shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple wireless room temperature sensors.
   2. The receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
   3. The receiver shall be capable of communication with sensors up to a distance of 200 Feet.
   4. The receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
   5. The receiver shall have LED indicators to provide information regarding the following conditions:
      a. Power: on/off.
      b. Ethernet: receiver activity/no activity.
      c. Wireless Normal Mode: transmission from sensors/no transmission.
      d. Wireless Rapid Transmit Mode: no transmission/weak signal/adequate signal/excellent signal.
      e. Ethernet Connection: No connection/10Mbps connection/100Mbps connection
      f. Network Activity: No network activity/half-duplex communication/full-duplex communication.

H. One-to-One Wireless Receiver:
   1. The One-To-One Wireless Receiver shall receive wireless radio frequency (RF) signals containing temperature data from multiple wireless room temperature sensors and communicate this information to field controllers via the communication bus.
   2. The receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
   3. The receiver shall be capable of communication with from one to five sensors up to a distance of 200 Feet.
   4. The receiver shall have LED indicators to provide information regarding the following conditions:
      a. Power.
      b. Communication Bus: Receiver activity/no activity.
      c. Wireless RF: Transmission from sensors/no transmission.
      d. Wireless Rapid Transmit Mode: No transmission/weak signal/adequate signal/excellent signal.

I. System Tools:
   1. Wireless Space Sensor Installation and Configuration Tools
      a. To enable installation and servicing when specialized tools are required, site survey and installation tools as well as software shall be provided to the contractor use for system installation and commissioning for the duration of the warranty period.
      b. To enable installation and servicing when specialized tools are required, site survey and installation tools as well as software shall be provided to the Owner for permanent possession for ongoing system maintenance and trouble shooting.

## 2.013 ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment.

C. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

D. Outdoor enclosures shall be NEMA 3R or NEMA 4X, as necessary for the site.

E. Enclosures shall have hinged, locking doors.

F. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

## 2.014 PROGRAMMABLE THERMOSTAT

A. Thermostat with 365 day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.

1. Manufacturers: Honeywell VisionPRO 8000 Series, Honeywell Prestige THX 9000 Series, Honeywell TB7600 Series, Venstar ColorTouch T6000 Series, EnTouch Pro/One.

B. Minimum thermostat features shall include, but not limited to, the following:

1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.
2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
3. The setback override shall be activated by a single button, and deactivated on demand.
4. Setpoints shall be adjustable from 35°F to 99°F, with a minimum 5°F adjustable deadband available.
5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75°F and heating setpoint of 70°F. Initial unoccupied mode cooling setpoint of 85°F and heating setpoint of 55°F.

C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.

1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
2. Emergency Heat switch will be provided on the touch screen when set in heat pump mode.

D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.

E. Controls shall be capable of alternating compressor starting sequence with a built-in lead-lag operating logic.

1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.

F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.

1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.

G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.

H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

### 3.02 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

### 3.03 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum three (3) feet of clear access space in front of units. Obtain approval on locations from Owner's Representative prior to installation.

B. Wall mounted temperature sensors will typically be mounted directly above or below light switches and comply with ADA height requirements. Coordinate with Owner, Architect and other trades to assure proper mounted locations prior to installation.

C. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.

D. Identify all equipment and panels. Provide permanently mounted tags for all panels.

E. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections, and sized to suit pipe diameter without restricting flow.

F. Occupancy sensors: provide hardware as necessary to install within ceiling type as shown in the Contract Documents. Install per manufacturer's requirements for full coverage of occupant locations within space. Coordinate with other ceiling items.

### 3.04 CONDUIT

A. Conduit Requirements: all conduit shall with comply with minimum requirements of local authority having jurisdiction.

1. Low voltage wiring in concealed areas may be plenum rated. Low voltage wiring in exposed areas shall be enclosed in conduit.
    a. All low voltage wiring exposed to weather shall be installed in conduit.
    b. Low voltage wiring in exposed areas, such as in mechanical, electrical, or service rooms, shall be installed in EMT conduit up to 10 feet above finished floor.
2. All low voltage control wiring in critical facilities and critical locations shall be enclosed in conduit.

B. Provide rigid conduit for low voltage wring in walls for all wall mounted sensors, CO2 sensors, humidity sensors, etc. Conduit shall be run to 6" (minimum) above the ceiling and shall terminate with a bushing installed on the conduit end. Flexible conduit shall not be used.

C. Provide conduit for low voltage wiring above inaccessible ceilings.

D. Conceal all conduits, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 12 inches (30 cm) from high-temperature equipment (i.e.-such as flues or high temperature pipes).

E. Conduit must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

F. Secure conduits with conduit clamps fastened to the structure and spaced according to code requirements. Conduits and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.

G. Size of conduit and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

**3.05 LOW VOLTAGE INTERLOCKING AND CONTROL WIRING**

A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.

B. All low-voltage wiring shall meet NFPA-70 (NEC) Article 725 Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.

C. Do not install Class 2 wiring (greater than 100 volts and protected by overcurrent device not over 20 amperes) in conduits containing Class 1 wiring (not exceeding 30 volts and 1000 volt-amperes). Boxes and panels containing line voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

D. Unless otherwise noted, power wiring for all valve and damper actuators is Class 2. If the BAS contractor desires to substitute 120-volt actuators, the BAS contractor shall coordinate directly with the General Contractor and Electrical Contractor to provide all 120-volt wiring and conduit at no additional cost to the Owner.

E. Contractor shall provide step-down transformers as necessary.

F. Install insulated bushings on all conduit ends and openings to enclosures. Seal top end of vertical conduits.

G. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block. Wire nuts are not acceptable.

H. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

I. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

J. Use color-coded conductors throughout with conductors of different colors.

K. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

L. The contractor shall terminate all communications, control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

**3.06 COMMUNICATION WIRING**

A. The contractor shall adhere to the wiring requirement previously listed.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling

C. Do not install communication wiring in conduits and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to manufacturer’s instructions.

G. All runs of communication wiring shall be unspliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:

1. The network shall use shielded, twisted-pair or stranded cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot). Wire gauge and wire type shall be sized and coordinated with manufacturer load requirements and lengths of runs.
2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
4. An MS/TP EIA-485 network shall have no T connections.

K. All Ethernet cabling, routers, hubs and switches for connecting 230900 furnished and installed control panels, servers and clients to the building Owner’s Ethernet network are the responsibility of the BAS contractor.

**3.07 MOTORIZED DAMPERS**

A. Where ducts penetrate an exterior surface install a Class I motorized damper at each outdoor air supply opening, return air opening, exhaust opening, relief outlet, shaft vent and stairway vent, as required to comply with minimum requirements of the local Energy Code.

1. Dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation,

unless the system served requires outdoor air or exhaust air or operates continuously or the dampers are opened to provide intentional economizer cooling.

2. Stairway and shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.

**3.08 FIELD SERVICES**

A. Prepare and start logic control system under provisions of this section.

B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation. Provide all labor and services as necessary to support testing and verification by third party commissioning authority.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.

D. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

**3.09 PROJECT RECORD DOCUMENTS**

A. Project Record Documents: Upon completion of installation, submit electronic copies of as-built documents. The documents shall be submitted for approval prior to final completion and shall include:

1. Project Record Drawings. As-built versions of the submittal shop drawings.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Part 3: "Control System Demonstration and Acceptance."
3. Operation and Maintenance (O & M) Manual.
4. As-built versions of submittal product data.
5. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
9. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.
10. Graphic files, programs, and database on magnetic or optical media.
11. List of recommended parts with part numbers and suppliers.
12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
14. Licenses, guarantees, and warranty documents for equipment and systems.
15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
16. Exported final sequences, diagrams, and points lists from the BAS at time of turnover.

17. All selected read/write points from integrated equipment and their labels.

**3.010 TRAINING**

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain BAS system.

B. Provide tuition for at least one individual to attend for a one-week factory training class. If applicable, costs for travel, lodging and meals will be the responsibility of the Owner.

C. Extent of Training:

1. Base extent of training on scope and complexity of BAS system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:
    a. Provide not less than 16 hours of training total.
    b. Stagger training over multiple training classes to accommodate Owner's requirements. All training to occur before end of warranty period.
    c. Break down total days of training into not more than four separate training classes.

D. Training Schedule:

1. Schedule training with Owner 20 business days, four weeks minimum, before expected Substantial Completion.
2. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with morning sessions and afternoon sessions as required. Training, including breaks and excluding lunch period, are not to exceed eight hours per day.
3. Provide staggered training schedule as requested by Owner’s Representative.

E. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number, and email address.
2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session. Indicate which attendees, if any, joined for only part of the training.

F. Training Attendee Headcount:

1. Plan in advance of training for a minimum of two to four attendees.
2. Make allowance for Owner to add up to two attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

G. Attendee Training Manuals:

1. Provide each attendee with all training materials and visual presentations in electronic format.

H. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors must have a minimum of five years of instructional training and BAS system experience on not less than five past projects with similar BAS system scope and complexity to BAS system installed.

I. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
   a. Daily operators.
   b. Advanced operators.
   c. System managers and administrators.
2. Plan and organize training sessions to group training content to protect BAS system security. Some attendees may be restricted to some training sessions to ensure BAS system security.

J. Training Outline:

1. Submit training outline for review by Owner's Representative at least ten (10) business days before scheduling training.
2. Include in outline a detailed agenda for each training day that is broken down into each training session, training objectives for each training session, and synopses for each lesson planned.

K. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. Use operator workstation that is to be used with BAS system in the training. If operator workstations are unavailable, provide temporary workstation to convey training content.

L. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project BAS system for use in training where feasible.
3. Provide operator workstation for use by each attendee.

M. Training Content for Daily Operators as Appropriate for Installed BAS System:

1. Basic operation of system.
2. Understanding BAS system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by BAS system including sequences of operation, each unique control algorithm, and each unique optimization routine.
5. Operating operator workstations, printers, and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports, and alarms.
8. Adjusting and changing set points and time schedules.

9. Recognizing BAS system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of BAS controllers and I/O hardware.
12. Accessing data from BAS controllers.
13. Operating portable operator workstations.
14. Review of BAS testing results to establish basic understanding of BAS system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating BAS system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by BAS system:
    a. Operation of HVAC equipment in normal-off, normal-on, and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
    b. For HVAC equipment with factory-installed software, show that integration into BAS system is able to communicate with BAS controllers or gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles, and other modes of operation indicated.
    d. Hardware interlocks and safeties function properly and BAS system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
    e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
    f. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
    g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

N. Training Content for Advanced Operators as Appropriate for Installed BAS System:
1. Making and changing workstation graphics.
2. Creating, deleting, and modifying alarms including annunciation and routing.
3. Creating, deleting, and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting, and modifying reports.
5. Creating, deleting, and modifying points.
6. Creating, deleting, and modifying programming including ability to edit control programs offline.
7. Creating, deleting, and modifying system graphics and other types of displays.

8. Adding BAS controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing BAS system checkout and diagnostic procedures.
11. Performing BAS controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring BAS system hardware including controllers, workstations, communication devices, and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing, and repairing hardware.
15. Adjusting, calibrating, and replacing BAS system components.

O. Training Content for System Managers and Administrators as Appropriate for Installed BAS System:

1. BAS system software maintenance and backups.
2. Uploading, downloading, and offline archiving of all BAS system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

P. Video of Training Sessions:

1. Provide digital video and audio recording of each training session. Create separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Owner with two copies of digital files on cloud and flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

**END OF SECTION**