This Addendum supersedes items of the original contract documents wherein it is inconsistent with it. All other conditions remain unchanged. The following changes, modifications, corrections, additions or clarifications shall apply to the contract documents and shall be made a part of and subject to all of the requirements thereof as if originally specified or shown. It is the responsibility of the bidder to review the list of attachments to ensure that the addendum is full and complete. This Addendum modifies the original Bid Documents for the above Bid.

Responses to Job Walk Questions

1. Do the control boards have available inputs for the new points?

Response: We are unable to determine if all of the locations have open inputs available. Bidders should quote for replacing 25 control boards. The average price will be used in the event that more than 25 control boards have to be replaced.

2. The Flow Meter and Temp sensor locations; can the Contractor put them in a different location if they find a better spot either for accuracy or convenience of placement?

Response: Yes, if the contractor finds a better location they can request modification to the design. Contractor will provide marked up drawings showing the preferred installation location and submit the drawings to Peralta for approval by Peralta engineering staff.

3. Will Peralta IT department work with the contractor to provide Ethernet "drops" where needed for controls?

Response: Yes

4. Can SOW's be put on the website?

Response: Yes, SOWs will be posted on the website

5. Can metering drawings be put on website.

Response: Yes, drawings will be posted to the website.

6. For the District Warehouse building, do all units have economizers?
Response: Yes. Units 8 and 9 are not connected to the Delta system. They need to be connected to the Delta system.

7. Does the District Warehouse already have an electric meter?

Response: Yes. Electrical use is not currently on the Delta system. Electric use needs to be connected to the data collection system.

8. Electrical Metering room in the District Warehouse has three panels in the room. None are where the drawing shows the main switchboard. Which panel should be used?

Response: There is a main switchboard outside the building where the PG&E meter is. There is also an existing Enernoc meter. The new electric meter will go there. The metering drawing is being updated.

9. For the District Administration building a HHW Flow meter is called for in the metering scope. There is a boiler but it appears to only serve to temper CHW for the Heat pumps. Seems like a BTU meter is not worth it.

Response: Instead of the HHW BTU meter, a gas meter will be installed. The drawings are being updated.

10. For the District Administration building there were questions about this building already having electric metering?

Response: Electrical use is not on the Delta system. Electric use needs to be connected to the data collection system.

11. For Laney College Building F, will CHW and HW BTU meters be required in multiple places?

Response: CHW and HW BTU meters will be required in 2 locations (4 meters total). One location is shown in the current design and a second location by the computer lab that is not in the design. The second meter will capture the usage for AHU1, 2, 3 in the computer lab. BTU meter line sizes may change. The drawings are being updated.

12. For Laney College Building F, the location for the BTU meter (this has been drawn in the ceiling of room 150) has challenging access.

Response: Contractor may request placement in a different location such as the penthouse.

13. For Laney College Building G, are drawings available?

Response: Yes, drawings will be posted to the district website.

14. For the Laney College Building G, AC1-has pneumatic actuators. Scope does not say to replace the actuators.

Response: Replace existing pneumatic actuators with DDC actuators. Troubleshoot dampers and replace if they are not functional. Scope will be updated.
15. For the Laney College Theater Building, BTU Meter location could not be accessed. Will access be provided?

Response: Work order has been placed by Theater staff to repair lock and provide access.

16. For the Laney College Admin Tower, it appears that the HW meter location will need to be changed.

Response: HW sensors will go further upstream than the drawings shown. There is a split off before that. The sensors can go in the same location as the CHW sensors or even further upstream outside of the room in the driveway. BTU Meter line sizes may change.

17. For the Laney College Library Building, the CHW for each AHU has its own feed from the main loop. How will this be metered?

Response: Two CHW meters will be needed. One must be installed in the original room, 113, and another installed in room 116. Each of the 2 AHUs has its own take-off for the cooling coil. In room 116 the venturi flow meter in the CHWR line is to be removed by contractor in order to make adequate space for an accurate flowmeter measurement in that pipe. Drawings are being updated.

18. For the Laney College Building B, are the HW BTU sensor locations being changed?

Response: Yes, the drawings are being updated.

19. For the Laney College Building B, Table 2 shows the Existing AHU damper dimensions. These dimensions for the EA dampers appear to be incorrect.

Response: Instead of 48” by 48” it should be a height of 82” and width of 90”. SOW has been modified.

20. For the College of Alameda Library Building, the SOW specifies use of an Alerton Control System? Are other systems allowed?

Response: Alerton or equivalent can be proposed. Peralta is interested in moving away from the Delta.

21. For Merritt College’s Building R, the drawings show metering for Building R going into room Q108. There are 2 rooms labeled Q108. Which is the right one?

Response: Temp sensors can go in the first Q108 as shown on the drawings. The flow meter may have to go in a better location for a straight run. The second room Q108 may be acceptable. Contractor can propose a better location during the project for approval by Peralta.

22. For Merritt College’s Building P, the plywood housing covering the CHW and HW piping, where the metering is supposed to go, is very rotten. Will the district repair this?
Modification to RFP

23. In section 2.1 Equipment and Campus Facilities, Table 1; PCCD Equipment Building List. Building number 12, College of Alameda, COA Building A, has be removed from the scope. There are only 14 buildings for this solicitation.

24. In Section 1.3.3.1 Investigation Phase, on page 10, has been removed from the scope.

25. In Section 4.2 Meter Equipment Price Proposal Breakdown the Table Meter Equipment Proposed Pricing, remove Building 13 College of Alameda Building A from the pricing proposal.

26. In Section 4.4 MBCx Equipment Price Proposal Breakdown Table Merritt College (MC) remove Investigation Phase from pricing proposal. Merritt College pricing proposal should only include the Implementation Phase and Reporting Phase.

27. In Section 4.4 MBCx Equipment Price Proposal Breakdown Table Laney College (LC) remove Investigation Phase from pricing proposal. Laney College pricing proposal should only include the Implementation Phase and Reporting Phase.

28. In Section 4.4 MBCx Equipment Price Proposal Breakdown Table College of Alameda (COA) remove Investigation Phase from pricing proposal. College of Alameda pricing proposal should only include the Implementation Phase and Reporting Phase.

END OF ADDENDUM
Laney College: Admin Tower
MBCx AHU Optimization

General Description
Optimize the energy use of the air handling units (AHU) serving Admin Tower at Laney College.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Replacement/installation of the outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors where applicable as indicated in the scope of work below.
- System commissioning is required for all systems included in this scope of work.
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>AHU Schedule Optimization</td>
</tr>
<tr>
<td>M3</td>
<td>Restore VFD Modulating Operation</td>
</tr>
</tbody>
</table>

Scope of Work
The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1  Produce Design Drawings
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

Task 2  Install Measure M1 Air Economizer Optimization
The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The systems included in the measure scope are SF-1 in the basement and SF-2 and SF-3 in the penthouse. The dampers, actuators, and valves appear to be in good condition. Control programming and sensors may be required. The tasks listed below outline the scope for this measure.

2.1 Check and calibrate existing air temperature sensors.

2.2 Provide and install new RAT and MAT sensors. These points did not appear in the trended data. For temperature sensor designation and count see Table 2A.

Table 2A: Air Temperature Sensor List

<table>
<thead>
<tr>
<th>Temperature Sensors</th>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SF-1</td>
<td>Calibrate</td>
<td>Calibrate</td>
<td>Calibrate</td>
<td>Calibrate</td>
</tr>
<tr>
<td></td>
<td>SF-2</td>
<td>Calibrate</td>
<td>1</td>
<td>1</td>
<td>Calibrate</td>
</tr>
<tr>
<td></td>
<td>SF-3</td>
<td>Calibrate</td>
<td>1</td>
<td>1</td>
<td>Calibrate</td>
</tr>
</tbody>
</table>

2.3 Check and repair operation of Hot water and Chilled Water Valves. The Chilled water valves do not appear to modulate. The valves should modulate to achieve the SAT setpoint.

2.4 Program the economizer operation as presented in Table 3.


**Table 3: Economizer Damper Control Strategy**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

- **AHU** = air handling unit
- **MAT** = mixed air temperature (RA mixed with OA)
- **OAT** = outdoor air temperature
- **RAT** = return air temperature (returned to AHU from conditioned space)
- **SAT** = supply air temperature (supplied to conditioned space as it is leaving the AHU)
- **OAF** = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.5 Commission the operation of all the newly installed components.

2.6 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.
Task 3  Install Measure M2 AHU Schedule Optimization

This measure consists of modifying operation schedules of the three air handlers (SF-1, SF-2 and SF-3) to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 4. This can be accomplished at the EMS level in coordination with campus staff.

3.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

3.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

3.4 Commission the proposed schedule and set-back operation.

Table 4: Initial Proposed HVAC Schedules

<table>
<thead>
<tr>
<th></th>
<th>SF-1</th>
<th>SF-2 and EF-3 (Currently 24/7)</th>
<th>SF-3 (Currently 24/7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon-Fri</td>
<td>6:00 AM to 10:00 PM</td>
<td>6:00 AM to 10:00 PM</td>
<td>6:00 AM to 10:00 PM</td>
</tr>
<tr>
<td>Sat</td>
<td>6:00 AM to 5:00 PM</td>
<td>6:00 AM to 5:00 PM</td>
<td>6:00 AM to 5:00 PM</td>
</tr>
<tr>
<td>Sun</td>
<td>8:00 AM to 12:00 PM</td>
<td>8:00 AM to 12:00 PM</td>
<td>8:00 AM to 12:00 PM</td>
</tr>
</tbody>
</table>

Task 4  Install Measure M3 Restore VFD Modulating Operation

The intent of this measure is to regain control of the SF-1 Supply and Exhaust Fans’ VFDs which had been connected to the EMS and are not currently modulating. The measure will reprogram the VFD control as necessary. The tasks listed below outline the scope for this measure.

4.1 Re-establish operation of VFDs from the control system.

4.2 Options for control:

4.2.1 Static Pressure: If field conditions indicate that the zones’ VAV boxes function well and static pressure will provide adequate control and modulation of the VFDs a static pressure setpoint can be used to control VFD speeds.

4.2.2 Load: Modify the control logic for the VFDs to modulate as a function of load which will be based on the RAT. The operation is shown in Table 5.
Table 5: Proposed VFD Control Based on Load

<table>
<thead>
<tr>
<th>Mode</th>
<th>RAT Setpoint (Initial)</th>
<th>VFD Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating or Deadband</td>
<td>72 Minimum</td>
<td>The minimum speed shall be optimized during the observation period. 30% speed can be used as a starting point.</td>
</tr>
<tr>
<td>Cooling</td>
<td>72 Minimum</td>
<td>The VFD speed shall change linearly as a function of the RAT.</td>
</tr>
<tr>
<td></td>
<td>80 Maximum</td>
<td></td>
</tr>
</tbody>
</table>

4.3 Commission VFD modulating control strategy.

4.4 After commissioning is completed the contractor is to observe the building conditions and optimize the VFD speed while making sure loads are satisfied. The optimization period should be at least three (3) days. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible. The setpoints will need to be adjusted in order to meet the following criteria.

4.4.1 The space is being heated adequately at the minimum speed.

4.4.2 The required ventilation air is being supplied to the space at all conditions while maintaining the lowers possible fan speed.

Task 5 Produce Measure Commissioning Documentation

5.1 Contractor will commission the operation of measures M1, M2 and M3 to insure that the systems are operating as described in this scope of work.

5.1.1 Perform Functional testing and trend review to commission the systems.

5.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

5.2.1 M1 Air Economizer Optimization

5.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer position
5.2.1.2 Provide a graph (Graph Name – Laney Admin Tower M1-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

5.2.1.3 Provide a graph (Graph Name - Laney Admin Tower M1-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

5.2.2 M2 AHU Schedule Optimization

5.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status
2. EF Status

5.2.2.2 Provide a graph (Graph Name - Laney Admin Tower M2-1), for each AHU, with at least one (1) week of data showing SF Status and EF Status on the Y-axis and Time (hourly) on the X-axis.

5.2.3 M3 Restore VFD Modulating Operation

5.2.3.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF VFD Speed
2. EF VFD Speed
3. Static Pressure
4. RAT
5. Depending on control strategy:
   a. Static Pressure setpoint
   Or
   a. RAT setpoint for VFD operation
   b. VFD Minimum Speed setpoint
   c. VFD Maximum Speed setpoint

5.2.3.2 Provide a graph (Graph Name – Laney Admin Tower M3-1), for SF-1, with at least one (1) week of data showing SF VFD Speed, EF VFD Speed, Static Pressure and RAT on the Y-axis and either Static Pressure or RAT, depending on the implemented control strategy, on the X-axis.
5.2.3.3 Provide a graph (Graph Name – Laney Admin Tower M3-2), for SF-1, with at least one (1) week of data showing SF VFD Speed, EF VFD Speed, Static Pressure and RAT on the Y-axis and Time (hourly) on the X-axis.

Task 6 Develop Measure Persistence Reports

6.1 Trends will be created for the parameters in Table 6. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 2: Points to be Trended

<table>
<thead>
<tr>
<th>System</th>
<th>Site</th>
<th>OAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>Economizer Position</th>
<th>SF VFD % Speed</th>
<th>EF VFD % Speed</th>
<th>Cooling Valve % Open</th>
<th>Static Pressure</th>
<th>Static Pressure SP</th>
<th>Supply Fan Status</th>
<th>Exhaust Fan Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>SF-2/EF-3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>SF-3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
<td>7</td>
</tr>
</tbody>
</table>

Total EMS Points 28

6.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Laney Admin Tower M1-1
- Laney Admin Tower M1-2
- Laney Admin Tower M2-1
- Laney Admin Tower M3-1
- Laney Admin Tower M3-2
Laney College: Building F  
MBCx AHU Optimization

**General Description**  
Optimize the energy use of the air handling units (AHU) serving Building F at Laney College.

**Contractor Requirements**  
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

**Special Requirements**  
- Work should be performed to meet seismic code  
- All mechanical work will be in accordance with ASHRAE and SMACNA standards  
- Design work should meet the California and local codes  
- The contractor will produce design drawings for owner approval before starting retrofit

**Schedule**  
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

**Purpose**  
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Functional testing and tuning of existing economizers.  
- System commissioning is required for all systems included in this scope of work.
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>Supply Air Temperature Reset</td>
</tr>
<tr>
<td>M3</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>

Scope of Work

The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1  Produce Design Drawings

Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements

Task 2  Install Measure M1 Air Economizer Optimization

The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. There are four units included in this measure. The included units are SF6F, AHU1F, AHU2F, and AHU3F. The tasks listed below outline the scope for this measure.

2.1 Verify that the dampers and actuators are functional on each unit. These may require lubrication, mechanical troubleshooting, or control system troubleshooting.

2.2 Verify that the temperature sensors are calibrated (OAT, RAT, MAT, SAT).

2.3 Perform functional tests to observe if the economizer operation is as presented in the Table 3.

2.4 If the economizer operation is not functioning per Table 3 contractor to correct the operation.

Table 2: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:
AHU = air handling unit
MAT = mixed air temperature (RA mixed with OA)
OAT = outdoor air temperature
RAT = return air temperature (returned to AHU from conditioned space)
SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)
OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.5 Commission the operation of all the newly installed components.

2.6 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

**Task 3  Install Measure M2 Supply Air Temperature Reset**

The intent of this measure is to modify the existing control logic of AHUs in order to fine-tune the existing Supply Air Temperature (SAT) reset strategy to minimize the AHUs cooling and heating energy use at partial load conditions. There are four units included in this measure. The included units are SF6F, AHU1F, AHU2F, and AHU3F. The tasks listed below outline the scope for this measure.

3.1 Revise the control logic to reset the SAT setpoint. The SAT setpoint shall change linearly as a function of OAT between listed OAT limits shown in Table 4 as a starting point.
Table 3: Initial SAT Reset Limits

<table>
<thead>
<tr>
<th>OAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>75°</td>
<td>60°</td>
</tr>
<tr>
<td>60°</td>
<td>64°</td>
</tr>
</tbody>
</table>

Table 4 shows target SAT reset limits. The actual reset limits will be determined in the field by testing the limits of each AHU to find the optimum reset schedule for each unit.

3.2 Commission SAT reset strategy.

3.3 After commissioning is completed the contractor is to observe the building conditions and optimize the reset strategy listed in Table 4 while making sure loads are satisfied. The optimization period should be at least three (3) days. The SAT temperatures for the reset strategy may be able to be widened to increase energy savings. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible.

Task 4. Install Measure M3 AHU Schedule Optimization

This measure consists of modifying operation schedules of AHUs to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

4.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 5. This can be accomplished at the EMS level in coordination with campus staff.

4.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

4.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

4.4 Commission the proposed schedule and set-back operation.

Table 4: Initial Proposed HVAC Schedules

<table>
<thead>
<tr>
<th>Proposed Schedule</th>
<th>SF2F</th>
<th>SF3F</th>
<th>SF4F</th>
<th>SF5F</th>
<th>SF6F</th>
<th>AHU1F</th>
<th>AHU2F</th>
<th>AHU3F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon-Fri</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
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</tr>
<tr>
<td></td>
<td>6:00 PM</td>
<td>6:00 PM</td>
<td>6:00 PM</td>
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<td>6:00 PM</td>
<td>6:00 PM</td>
<td>6:00 PM</td>
<td>6:00 PM</td>
</tr>
<tr>
<td>Sat</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
<td>7:00 AM to</td>
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<tr>
<td>Sun</td>
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<td>5:00 PM</td>
<td>5:00 PM</td>
<td>5:00 PM</td>
<td>5:00 PM</td>
</tr>
</tbody>
</table>
Task 5  Produce Measure Commissioning Documentation

5.1 Contractor will commission the operation of measures M1, M2, and M3 to insure that the systems are operating as described in this scope of work.

5.1.1 Perform Functional testing and trend review to commission the systems.

5.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

5.2.1 M1 Air Economizer Optimization

5.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

   1. OAT
   2. RAT
   3. MAT
   4. SAT
   5. Economizer position

5.2.1.2 Provide a graph (Graph Name – Laney Building F M1-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

5.2.1.3 Provide a graph (Graph Name – Laney Building F M1-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

5.2.2 M2 Supply Air Temperature Reset

5.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

   1. Chilled Water Valve position
   2. SAT
   3. SAT Setpoint
   4. OAT

5.2.2.2 Provide a graph (Graph Name – Laney Building F M2-1), for each AHU, with at least one (1) week of data showing the above points as a function of OAT, where Chilled Water Valve position, SAT, and SAT setpoint are plotted on the Y-axis and OAT is plotted on the X-axis.

5.2.2.3 Provide a graph (Graph Name – Laney Building F M2-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs.
time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

5.2.4 M3 AHU Schedule Optimization

5.2.4.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status
2. RF or EF Status if applicable.

5.2.4.2 Provide a graph (Graph Name – Laney Building F M3-1), for each AHU, with at least one (1) week of data showing SF Status and RF Status on the Y-axis and Time (hourly) on the X-axis.

Task 6 Develop Measure Persistence Reports

6.1 Trends will be created for the parameters in Table 7. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 5: Points to be Trended

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>Economizer Position</th>
<th>SF VFD % Speed</th>
<th>Chilled Water Valve % Open</th>
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<th>Supply Fan Status</th>
<th>Return/Exhaust Fan Status</th>
<th>Total System Points</th>
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</thead>
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<td>1</td>
<td>9</td>
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<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

Total EMS Points 47
6.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Laney Building F M1-1
- Laney Building F M1-2
- Laney Building F M2-1
- Laney Building F M2-1
- Laney Building F M3-1
District Admin Building
MBCx AHU Optimization

General Description
Optimize the energy use of the air handling units (AHU) serving the District Admin Building.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
• Work should be performed to meet seismic code
• All mechanical work will be in accordance with ASHRAE and SMACNA standards
• Design work should meet the California and local codes
• The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:
• Installation of mixed air temperature (MAT) sensors where applicable
• Check and tune functionality of the dampers and actuators
• Adjust scheduling
• System commissioning is required for all systems included in this scope of work
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>

**Scope of Work**

The scope of work for this building, as shown above in Table 1, is presented in detail below.

**Task 1  Produce Design Drawings**

Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

**Task 2  Install Measure M1 Air Economizer Optimization**

The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. Include fourteen (12) of the fifteen (15) units in the building (except for HP 10, AC-1, and AC-2). The tasks listed below outline the scope for this measure.

2.1 None of the units have a MAT sensor. Install a MAT sensor in each of the units and connect to the existing control system so that they can be seen on the current EMS (see Table 2).

2.2 Verify that the temperature sensors are calibrated (OAT, RAT, MAT, SAT).

2.3 Verify that the dampers and actuators are functional on each unit. These may require lubrication, mechanical troubleshooting, or control system troubleshooting.

**Table 2: Air Temperature Sensor List**

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP2</td>
<td>1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HP2a</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP4a</td>
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<td>HP4b</td>
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<td>HP6</td>
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<td>HP7</td>
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<td>HP8</td>
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<tr>
<td>HP9</td>
<td>1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HP11</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.4 Perform functional tests to observe if the economizer operation is as presented in Table 3.

2.5 If the economizer operation is not functioning per Table 3, contractor is required to correct the operation.

**Table 3: Economizer Damper Control Strategy**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

- **AHU**: air handling unit
- **MAT**: mixed air temperature (RA mixed with OA)
- **OAT**: outdoor air temperature
- **RAT**: return air temperature (returned to AHU from conditioned space)
- **SAT**: supply air temperature (supplied to conditioned space as it is leaving the AHU)
- **OAF**: outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU's Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature
than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.6 Commission the operation of all the MAT sensors.

2.7 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

Task 3 Install Measure M2 AHU Schedule Optimization

This measure consists of modifying operation schedules of 12 of the HP units to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 4. This can be accomplished at the EMS level in coordination with campus staff.

3.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

3.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

3.4 Commission the proposed schedule and set-back operation.

Table 4: Initial Proposed HVAC Schedules

<table>
<thead>
<tr>
<th></th>
<th>HP1</th>
<th>HP2</th>
<th>HP2a</th>
<th>HP3</th>
<th>HP4a</th>
<th>HP4b</th>
<th>HP5</th>
<th>HP6</th>
<th>HP7</th>
<th>HP8</th>
<th>HP9</th>
<th>HP11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon-Fri</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
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<td>7:00 AM to 6:00 PM</td>
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<tr>
<td>Sat</td>
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</tr>
</tbody>
</table>

Task 4 Produce Measure Commissioning Documentation

4.1 Contractor will commission the operation of measures M1 and M2 to insure that the systems are operating as described in this scope of work.
4.1.2 Perform Functional testing and trend review to commission the systems.

4.2 Contractor will provide confirmation that systems are operating correctly on all units listed in this scope of work.

4.2.1 M1 Air Economizer Optimization

4.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT

4.2.1.2 Provide a graph (Graph Name – District Admin M1-1), for each HP, with at least one (1) week of data showing RAT, MAT, and SAT as function of OAT, where the RAT, MAT, and SAT are plotted on the Y-axis and OAT on the X-axis.

4.2.1.3 Provide a graph (Graph Name – District Admin M1-2), for each HP, with at least one (1) week of data showing OAT, MAT, RAT, and SAT vs. time, where OAT, MAT, RAT, and SAT are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

4.2.2 M2 AHU Schedule Optimization

4.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status for each of the 12 HP units

4.2.2.2 Provide a graph (Graph Name – District Admin M2-1), for each HP, with at least one (1) week of data showing SF Status on the Y-axis and Time (hourly) on the X-axis.

Task 5 Develop Measure Persistence Reports

5.1 Trends will be created for the parameters in Table 5. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.
Table 5: Points to be Trended

<table>
<thead>
<tr>
<th>EMS Trends</th>
<th>OAT</th>
<th>SAT</th>
<th>RAT</th>
<th>MAT</th>
<th>Zone Temp</th>
<th>Zone Temp Setpoint</th>
<th>Reversing Valve Status</th>
<th>Supply Fan Status</th>
<th>Compressor 1 Status</th>
<th>Compressor 2 Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
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<td>HP6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>HP7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>HP8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>HP9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>HP11</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Total EMS Points: 113

5.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- District Admin M1-1
- District Admin M1-2
- District Admin M2-1
Peralta District Warehouse Building
MBCx AHU Optimization

**General Description**
Optimize the energy use of the air handling units (AHU) serving the Peralta District Warehouse Building.

**Contractor Requirements**
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

**Special Requirements**
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

**Schedule**
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

**Purpose**
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:
- Check and tune functionality of the dampers and actuators
- Adjust scheduling
- System commissioning is required for all systems included in this scope of work

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M3</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>
Scope of Work
The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1  Produce Design Drawings
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

Task 2  Install Measure M1 Air Economizer Optimization
The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. This measure includes seven (7) of the nine (9) AC units in the building (also referred to as AHU). The units that are excluded are AC3 and AC4 which serve the computer room. The tasks listed below outline the scope for this measure.

2.1 Verify that the dampers and actuators are functional on each unit. These may require lubrication, mechanical troubleshooting, or control system troubleshooting.

2.2 Verify that the temperature sensors are calibrated (OAT, RAT, MAT, SAT- as available).

2.3 Perform functional tests to observe if the economizer operation is as presented in the Table 2.

2.4 If the economizer operation is not functioning per Table 2 contractor to correct the operation.

Table 2: Economizer Damper Control Strategy
Peralta District Warehouse Building/General Services

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

AHU = air handling unit

MAT= mixed air temperature (RA mixed with OA)

OAT = outdoor air temperature

RAT = return air temperature (returned to AHU from conditioned space)

SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)

OAF = outdoor air flow
The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.5 Commission the operation of all the newly installed components.

2.6 Commission the economizer operation per the control strategy shown in Table 2. Functional testing and trend review will be required.

**Task 3 Install Measure M2 AHU Schedule Optimization**

The intent of this measure is to optimize the operation of the AHUs to eliminate operation when the building is not occupied. This measure includes seven (7) of the nine (9) units in the building (except AC3 and AC4 which serve the computer room).

All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 3. This can be accomplished at the EMS level in coordination with campus staff.

3.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

3.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.
3.4. Commission the proposed schedule and set-back operation.

**Table 3: Initial Proposed HVAC Schedules**

<table>
<thead>
<tr>
<th>Mon-Fri</th>
<th>AC-1</th>
<th>AC-2</th>
<th>AC-5</th>
<th>AC-6</th>
<th>AC-7</th>
<th>AC-8</th>
<th>AC-9</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td></td>
</tr>
<tr>
<td>Sat</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td>Sun</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
</tbody>
</table>

**Task 4: Produce Measure Commissioning Documentation**

4.1 Contractor will commission the operation of measures M1 and M2 to insure that the systems are operating as described in this scope of work.

4.2.1 Perform Functional testing and trend review to commission the systems.

4.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

4.2.1 M1 Air Economizer Optimization

4.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.
4.2.1.2 For AC-1 through 6: Provide a graph (Graph Name – District Warehouse M1-1), with at least one (1) week of data showing economizer position as function of OAT, where the economizer Position is plotted on the Y-axis and OAT on the X-axis.

4.2.1.3 For AC-7: Provide a graph (Graph Name - District Warehouse M1-2), with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position as a function of OAT, where the OAT, MAT, RAT, SAT, and economizer position is plotted on the Y-axis and OAT on the X-axis.

4.2.1.4 For AC-8 and AC-9: Provide a graph (Graph Name - District Warehouse M1-3), with at least one (1) week of data showing compressor status and heating status as a function of OAT, where the compressor status and heating status are plotted on the Y-axis and OAT on the X-axis.

4.2.1.5 For AC-7: Provide a graph (Graph Name – District Warehouse M1-4), with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and economizer Position are plotted on the Y-axis and time (hourly) is plotted on the X-axis.

4.2.2 M2-AHU Schedule Optimization

4.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.
1. SF Status or Fan Enable

4.2.2.2 Provide a graph (Graph Name - District Warehouse M2-1), for each AHU, with at least one (1) week of data showing the SF Status or Fan Enable points versus time where SF Status or Fan Enable is the Y-axis and Time (hourly) on the X-axis.

Task 5 Develop Measure Persistence Reports

5.1 Trends will be created for the parameters in Table 5. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. This data will be used for measure verification. The EMS or Reporting System will provide the data export in CSV format.

### Table 2: Points to be Trended

<table>
<thead>
<tr>
<th>System</th>
<th>Site</th>
<th>OAT</th>
<th>RAT</th>
<th>SAT</th>
<th>MAT</th>
<th>Economizer or bypass damper percent</th>
<th>Zone Setpoint</th>
<th>Zone Temp</th>
<th>Compressor Status</th>
<th>Heating Status</th>
<th>Fan Enable</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC-1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
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<td>1</td>
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<td>AC-2</td>
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<td>1</td>
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<td>AC-6</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>AC-7</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC-8</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
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<td></td>
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<td>5</td>
</tr>
<tr>
<td>AC-9</td>
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<td>1</td>
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<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- District Warehouse M1-1
- District Warehouse M1-2
- District Warehouse M1-3
- District Warehouse M1-4
- District Warehouse M2-1
Merritt College Building R
MBCx AHU Optimization

General Description
Optimize the energy use of the air handling units (AHU) serving Building R at Merritt College.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Replacement of existing outdoor air (OA), return air (RA), exhaust air (EA) dampers where applicable as indicated in the scope of work below
- Replacement of the existing pneumatic damper actuators with electronic actuators where applicable as indicated in the scope of work below
- Replacement of the existing pneumatic/manual chilled water and heating hot water valves with electronic valves where applicable as indicated in the scope of work below
- Replacement/installation of the outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors where applicable as indicated in the scope of work below
- System commissioning is required for all systems included in this scope of work
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>AHU Schedule Optimization</td>
</tr>
<tr>
<td>M3</td>
<td>Restore VFD Modulating Operation</td>
</tr>
<tr>
<td>M4</td>
<td>Remove Inlet Guide Vanes-only S1Q</td>
</tr>
</tbody>
</table>

**Scope of Work**

The scope of work for this building, as shown above in Table 1, is presented in detail below.

**Task 1  Produce Design Drawings**

Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

**Task 2  Install Measure M1 Air Economizer Optimization**

The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The two (2) systems included in the measure scope are S1Q located in the basement and S1R located on the roof penthouse. The tasks listed below outline the scope for this measure:

1. Remove existing air dampers and associated pneumatic damper actuators for S1Q.
2. Remove existing air temperature sensors for S1Q.
3. Provide and install new air dampers and new electronic damper actuators for S1Q. For damper nominal sizes see Table 2. Contractor must site verify damper opening sized before ordering dampers.

Table 2: Existing AHU Components

<table>
<thead>
<tr>
<th>NOMINAL OPENING FOR DAMPERS (Inches)</th>
<th>DAMPER ACTUATOR INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>OA</td>
</tr>
<tr>
<td>5-1-Q- Basement</td>
<td>120</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHILLED WATER VALVE INFORMATION</th>
<th>HEATING HOT WATER VALVE INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>2-WAY/3-WAY</td>
</tr>
<tr>
<td>5-1-Q- Basement</td>
<td>3-WAY</td>
</tr>
</tbody>
</table>
2.4 Provide and install new air temperature sensors for S1Q. For temperature sensor designation and count see Table 2A.

Table 2A: Air Temperature Sensor List

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1Q</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2.5 Program the economizer operation for S1Q and S1R as presented in Table 3. Currently the S1R economizer position is only at 10% or at 100%.

Table 3: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

AHU = air handling unit
MAT = mixed air temperature (RA mixed with OA)
OAT = outdoor air temperature
RAT = return air temperature (returned to AHU from conditioned space)
SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)
OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**
During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.6 Commission the operation of all the newly installed components.

2.7 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

**Task 3. Install Measure M2 AHU Schedule Optimization**

This measure consists of modifying operation schedules of the AHUs to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 4. This can be accomplished at the EMS level in coordination with campus staff.

3.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

3.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

3.4 Commission the proposed schedule and set-back operation.

<table>
<thead>
<tr>
<th></th>
<th>S1Q</th>
<th>S1R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposed Schedule</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mon-Fri</td>
<td>6:00 AM to 10:00 PM</td>
<td>6:00 AM to 10:00 PM</td>
</tr>
<tr>
<td>Sat</td>
<td>6:00 AM to 5:00 PM</td>
<td>6:00 AM to 5:00 PM</td>
</tr>
<tr>
<td>Sun</td>
<td>8:00 AM to 12:00 PM</td>
<td>8:00 AM to 12:00 PM</td>
</tr>
</tbody>
</table>

*Table 4: Initial Proposed HVAC Schedules*
Task 4: Measure M3 Restore VFD Modulation Operation

The intent of this measure is to regain control of the VFDs which had been connected to the EMS and are not currently modulating effectively. The measure will reprogram the VFD control as necessary. The tasks listed below outline the scope for this measure.

4.1 Install a new static pressure sensor for S1Q

4.1.1 The existing sensor may be unreliable as it shows very low values of 0.5 in H2O. Investigation may show that it can be made operational.

4.1.2 If it is to be replaced, contractor to determine the optimal location for the sensor. Preferred location is 2/3 of the duct length.

4.2 Verify or calibrate static pressure sensor for S1R. (Replace if necessary)

4.2.1 It shows values of 1in H2O. The setpoint is 1 in H2O.

4.2.2 If it is to be replaced, contractor to determine the optimal location for the sensor. Preferred location is 2/3 down the length of the duct.

4.3 Re-establish operation of VFDs from the control system

4.4 Options for control

4.4.1 Static Pressure. If field conditions indicate that the zones VAV boxes function well and static pressure will provide adequate control and modulation of the VFDs a static pressure setpoint can be used to control VFD speeds.

4.4.2 Load. Modify the control logic for the VFDs to modulate as a function of load which will be based on the RAT. The operation is shown in Table 5. The system will have to be tuned so that there is no “hunting”.

Table 5: Proposed VFD Control Based on Load

<table>
<thead>
<tr>
<th>Mode</th>
<th>RAT Setpoint (Initial)</th>
<th>VFD Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating or Deadband</td>
<td>72</td>
<td>Minimum The minimum speed shall be optimized during the observation period. 40% speed can be used as a starting point.</td>
</tr>
<tr>
<td>Cooling</td>
<td>72</td>
<td>Minimum The VFD speed shall change linearly as a function of the RAT.</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>Maximum</td>
</tr>
</tbody>
</table>

4.5 Commission VFD Control strategy.

4.6 After commissioning is completed the contractor is to observe the building conditions and optimize the VFD speed while making sure loads are satisfied. The optimization period should at least three (3) days. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible. The setpoints will need to be adjusted in order to meet the following criteria.
4.6.1 The space is being heated adequately at the minimum speed
4.6.2 The required ventilation air is being supplied to the space at all conditions while maintaining the lowest possible fan speed.

Task 5: Measure M4 Remove Inlet Guide Vanes – only S1Q

The intent of this measure is to reduce the pressure drop across the fan by removing the Inlet Guide Vanes (IGV). Coordinate with the customer the required fan downtime to remove IGV.

Task 6: Produce Measure Commissioning Documentation

6.1 Contractor will commission the operation of measures M1, M2, M3 and M4 to insure that the systems are operating as described in this scope of work.

6.1.1 Perform Functional testing and trend review to commission the systems

6.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

6.2.1 M1 Air Economizer Optimization

6.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer position

6.2.1.2 Provide a graph (Graph Name - Building R M1-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

6.2.1.3 Provide a graph (Graph Name - Building R M1-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

6.2.2 M2 AHU Schedule Optimization

6.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status
2. RF /EF Status
6.2.2.2 Provide a graph (Graph Name - Building R M2-1), for each AHU, with at least one (1) week of data showing the above points versus time, where the SF Status and the RF/EF status are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

6.2.3 M3 Restore VFD Modulating Operation

6.2.3.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF VFD Status
2. RF /EF Status
3. Static Pressure
4. RAT
5. Depending on control strategy:
   a. Static pressure setpoint
   OR
   b. RAT setpoint for VFD operation
   c. VFD minimum speed setpoint
   d. VFD maximum speed setpoint

6.2.3.2 Provide a graph (Graph Name - Building R M3-1), for each AHU, with at least one (1) week of data showing the SF VFD Speed, RF VFD Speed, Static Pressure and RAT on the Y-axis and either Static Pressure or RAT, depending on the implemented control strategy, on the X-axis.

6.2.3.3 Provide a graph (Graph Name - Building R M3-2), for each AHU, with at least one (1) week of data showing SF VFD Speed, RF VFD Speed, Static Pressure and RAT on the Y-axis and Time (hourly) on the X-axis.

6.2.4 M4 Remove Inlet Guide Vanes – only on S1Q

6.2.3.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF VFD Speed
2. Static Pressure
3. RAT

6.2.3.2 Provide a graph (Graph Name - Building R M4-1), for S1Q, with at least one (1) week of data showing the Static Pressure on the Y-axis and RAT on the X-axis.

6.2.3.3 Provide a graph (Graph Name - Building R M4-2), for S1Q, with at least one (1) week of data showing SF VFD Speed, Static Pressure and RAT on the Y-axis and Time (hourly) on the X-axis.
Task 7. Develop Measure Persistence Reports

7.1 Trends will be created for the parameters in Table 7. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 7: Points to be Trended

| System | Site | OAT | SAT | SAT SP | RAT | MAT | Preheat Temp | Economizer Position | Chilled Water Valve % Open | Heating Valve % Open | Static Pressure Setpoint | Static Pressure | Supply Fan Status | Return/Exhaust Fan Status | SF VFD Speed | RF/EF VFD Speed | Total System Points |
|--------|------|-----|-----|--------|-----|-----|--------------|------------------------|----------------------------|-----------------------|---------------------|---------------------|------------------|-----------------------|------------------------|--------------|----------------|------------------|
|        |      |     |     |        |     |     |              |                        |                            |                       |                     |                    |                  |                       |                        |              |                |                  |
| S1Q    | 1    | 1   | 1   | 1      | 1   | 1   | 1            | 1                      | 1                          | 1                     | 1                   | 1                  | 1                 | 1                      | 1                      |              |                |                  |
| S1R    | 1    | 1   | 1   | 1      | NA  | 1   | 1            | NA                     | 1                          | 1                     | 1                   | 1                  | 1                 | 1                      | 1                      |              |                |                  |

Total EMS Points 27

7.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Merritt College Building R M1-1
- Merritt College Building R M1-2
- Merritt College Building R M2-1
- Merritt College Building R M3-1
- Merritt College Building R M3-2
- Merritt College Building R M4-1
- Merritt College Building R M4-2
Merritt Building P
MBCx AHU Optimization

General Description
Optimize the energy use of the air handling units (AHU) serving Merritt College Building P.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Replacement of existing outdoor air (OA), return air (RA), exhaust air (EA) dampers where applicable.
- Replacement of the existing pneumatic damper actuators with electronic actuators where applicable.
- Replacement of the existing pneumatic/manual chilled water and heating hot water valves with electronic valves where applicable.
- Replacement/installation of the outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors where applicable.
- System commissioning is required for all systems included in this scope of work.
### Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>

### Scope of Work

The scope of work for this building, as shown above in Table 1, is presented in detail below.

**Task 1  Produce Design Drawings**

Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

**Task 2  Install Measure M1 Air Economizer Optimization**

The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The system included in the measure scope is S1P. The tasks listed below outline the scope for this measure.

2.1 Remove existing air dampers and associated pneumatic damper actuators

2.2 Remove existing air temperature sensors

2.3 Provide and install new air dampers and new electronic damper actuators. For damper nominal sizes see Table 2. Contractor must site verify damper opening sizes prior to ordering dampers.

### Table 2: Existing AHU Components

<table>
<thead>
<tr>
<th>System</th>
<th>NOMINAL OPENING FOR DAMPERS (Inches)</th>
<th>DAMPER ACTUATOR INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DA</td>
<td>RA</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>S1P</td>
<td>60</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Pneumatic</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2-WAY/ PNEUMATIC/ MANUAL SIZE FLOW PD CV</th>
<th>2-WAY/ PNEUMATIC/ MANUAL SIZE FLOW PD CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHILLED WATER VALVE INFORMATION</td>
<td>HEATING HOT WATER VALVE INFORMATION</td>
</tr>
<tr>
<td>System</td>
<td>System</td>
</tr>
<tr>
<td>3-WAY DDC (Inches)</td>
<td>6 x 3-Way Pneumatic</td>
</tr>
<tr>
<td>No Cooling</td>
<td></td>
</tr>
</tbody>
</table>

2.4 Provide and install new air temperature sensors. For temperature sensor designation and count see Table 2A.
Table 2A: Air Temperature Sensor List

<table>
<thead>
<tr>
<th>Temperature Sensors</th>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1P</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2.5 Program the economizer operation as presented in Table 3

Table 3: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

AHU = air handling unit  
MAT = mixed air temperature (RA mixed with OA)  
OAT = outdoor air temperature  
RAT = return air temperature (returned to AHU from conditioned space)  
SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)  
OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the
operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or \( \text{MAT} = \text{SAT} \).

2.6 Commission the operation of all the newly installed components.

2.7 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

Task 3 Install Measure M2 AHU Schedule Optimization

This measure consists of modifying operation schedules of all eight (8) units to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 4. This can be accomplished at the EMS level in coordination with campus staff.

3.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

3.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

3.4 Commission the proposed schedule and set-back operation.

Table 4: Initial Proposed HVAC Schedules

<table>
<thead>
<tr>
<th></th>
<th>Proposed Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S1P</strong></td>
<td><strong>AHU-3P</strong></td>
</tr>
<tr>
<td>Mon-Fri</td>
<td>6:00 AM to 10:00 PM</td>
</tr>
<tr>
<td>Sat</td>
<td>6:00 AM to 5:00 PM</td>
</tr>
<tr>
<td>Sun</td>
<td>8:00 AM to 12:00 PM</td>
</tr>
</tbody>
</table>

Task 4: Produce Measure Commissioning Documentation

4.1 Contractor will commission the operation of measures M1 and M2 to insure that the systems are operating as described in this scope of work.

4.1.1 Perform Functional testing and trend review to commission the systems.
4.2 Contractor will provide confirmation that all the AHUs listed in the scope of work are operating correctly.

4.2.1 M1 Economizer Optimization

4.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel. Provide for S1P:

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer Position

4.2.1.2 Provide a graph (Graph Name – Merritt Building P M1-1), with at least one (1) week of data showing economizer position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

4.2.1.3 Provide a graph (Graph Name - Merritt Building P M1-2), one (1) of data showing OAT, MAT, RAT, SAT, and economizer position vs. time., where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

4.2.2 M2 AHU Schedule Optimization

4.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel. Provide for all eight (8) units:

1. SF Status
2. EF Status (only S1P)

4.2.2.2 Provide a graph (Graph Name - Merritt Building P M2-1), for each AHU and HP, with at least one (1) week of data showing SF Status and EF Status on the Y-axis and Time (hourly) on the X-axis.

Task 5 Develop Measure Persistence Reports

5.1 Trends will be created for the parameters in Table 5. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.
Table 5: Points to be Trended

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>Economizer Position</th>
<th>Supply Fan Status</th>
<th>Exhaust Fan Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-1P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>AHU-3P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>HP1</td>
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<tr>
<td>HP2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP3</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HP5</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HP6</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total EMS Points</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Merritt Building P M1-1
- Merritt Building P M1-2
- Merritt Building P M2-1
Merritt Building A
MBCx AHU Optimization

General Description
Optimize the energy use of the air HVAC and hot water pumping serving Merritt College Building A.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the building systems will be made and are included as part of this proposal. This includes the installation or repair of the following:
- Programming of basic thermostats.
- Installation of hot water pump, motor, VFD, and static pressure controls.
- System commissioning is required for all systems included in this scope of work.

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Thermostat Programming</td>
</tr>
<tr>
<td>M2</td>
<td>Retrofit Heating Hot Water Pump</td>
</tr>
</tbody>
</table>
**Scope of Work**
The scope of work for this building, as shown above in Table 1, is presented in detail below.

**Task 1  Produce Design Drawings**
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

**Deliverable** – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements

**Task 2  Measure M1 Thermostat Programming**
This measure consists of modifying operation schedules of five (5) stand-alone thermostats to eliminate operation when the building is not occupied. The thermostats are all located in the security area on the first floor of building A. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

2.1 Set the time on each thermostat.

2.2 Set the schedule on each thermostat according to Table 2.

2.3 Commission the proposed schedule and set-back operation. Spot check is adequate.

**Table 2: Initial Proposed Thermostat Programming**

<table>
<thead>
<tr>
<th></th>
<th>Unit Schedule</th>
<th>Unit Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP1 - Unlabeled in back office</td>
<td>Use Unoccupied program below.</td>
<td>7:00 AM to 10:00 PM</td>
</tr>
<tr>
<td>HP2 - Storage area</td>
<td>Use Unoccupied program below.</td>
<td>7:00 AM to 10:00 PM</td>
</tr>
<tr>
<td>HP3 - Main room</td>
<td>7:00 AM to 10:00 PM</td>
<td>7:00 AM to 5:00 PM</td>
</tr>
<tr>
<td>HP4 - Entrance room</td>
<td>7:00 AM to 5:00 PM</td>
<td>72</td>
</tr>
<tr>
<td>HP5 - Office</td>
<td>7:00 AM to 5:00 PM</td>
<td>65</td>
</tr>
<tr>
<td>Fan</td>
<td>Cool to</td>
<td>Heat to</td>
</tr>
</tbody>
</table>

**Task 3 Install Measure M2 Retrofit Heating Hot Water Pump**
This measure consists of modifying Hot Water pumping to increase capacity and allow the pump to modulate down when the load is reduced. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Remove the existing Heating Hot water pump and the associated 3 HP motor.
3.2 Install a new pump, motor, and VFD. Existing pump is undersized, contractor to determine adequate size to meet the building HW system flow and pressure requirements. Contractor to collect flow and pressure measurements. It is estimated that a 5 HP pump, motor, and VFD will be required.
3.3 Install a static pressure sensor in the hot water piping in a location that will allow for control of the VFD.
3.4 The new motor and VFD shall be integrated into the current building EMS.
3.5 Implement controls to modulate the pump based on the static pressure.
3.6 Commission the new pump and VFD modulating operation.

Task 4 Produce Measure Commissioning Documentation

4.1 Contractor will commission the operation of measures M1 and M2 to insure that the systems are operating as described in this scope of work.
   4.1.1 Perform Functional testing and trend review to commission the systems.

4.2 Contractor will provide confirmation that systems are operating correctly on all systems listed in this scope of work.
   4.2.1 M1 Thermostat Programming.
       4.2.1.1 Provide timestamped photographs of each thermostat to verify operation and schedule.
   4.2.2 M2 Retrofit Heating Hot Water Pump.
       4.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.
           • HW pump status
           • HW pump percent speed
           • HW static pressure
           • HW static pressure setpoint
           • HW Supply Temperature
           • HW Return Temperature
           • Outside Air Temperature
       4.2.2.2 Provide a graph (Graph Name – Merritt Building A M2-1), with at least one (1) week of data showing the above points versus time, where HW pump status, HW pump percent speed, HW static pressure, HW static pressure set point, Outside Air Temperature (OAT) are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.
       4.2.2.3 Provide a graph (Graph Name – Merritt Building A M2-2), with at least one (1) week of data showing the HW Supply Temperature and HW Return Temperature as a function of OAT, where HW Supply Temperature and HW Return Temperature are plotted on the Y-axis and OAT is plotted on the X-axis.
Task 5  Develop Measure Persistence Reports

5.1 Trends will be created for the parameters in Table 3. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 3: Points to be Trended

<table>
<thead>
<tr>
<th>EMS Trends</th>
<th>OAT</th>
<th>HW pump status</th>
<th>HW pump percent speed</th>
<th>HW Pump static pressure</th>
<th>HW static pressure setpoint</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site</td>
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<tr>
<td>HHW</td>
<td>1 1 1 1</td>
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<td>Total EMS Points</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

5.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following report will be created:

- Merritt Building A M2-1
- Merritt Building A M2-2
Merritt Building D
MBCx AHU Optimization

General Description
Optimize the energy use of the air handling units (AHU) serving Merritt College Building D.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
• Work should be performed to meet seismic code
• All mechanical work will be in accordance with ASHRAE and SMACNA standards
• Design work should meet the California and local codes
• The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

• Replacement of existing outdoor air (OA), return air (RA), exhaust air (EA) dampers where applicable.
• Replacement of the existing pneumatic damper actuators with electronic actuators where applicable.
• Replacement of the existing pneumatic/manual chilled water and heating hot water valves with electronic valves where applicable.
• Replacement/installation of the outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors where applicable.
• System commissioning is required for all systems included in this scope of work.
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>

Scope of Work
The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1  Produce Design Drawings
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

Task 2  Install Measure M1 Air Economizer Optimization
The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The systems included in the measure scope are S1D and S2D. Tasks are outlined below.

2.1 Remove existing air dampers and associated pneumatic damper actuators.

2.2 Remove existing air temperature sensors.

2.3 Provide and install new air dampers and new electronic damper actuators. For damper nominal sizes see Table 2. Contractor must site verify damper opening sizes prior to ordering dampers.

2.4 Remove existing HHW pneumatic (Assumed that the original HHW valves have not been replaced).

2.5 Install new DDC HHW control valves for S1D and S2D. For proposed valve details see Table 2A. Contractor must site verify valve size and CV before ordering new valves.

Table 2: Existing AHU Components

<table>
<thead>
<tr>
<th>System</th>
<th>Nominal Opening for Dampers (inches)</th>
<th>Damper Actuator Information</th>
<th>CHILLED WATER VALVE INFORMATION</th>
<th>HEATING HOT WATER VALVE INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1D</td>
<td>120</td>
<td>99</td>
<td>36</td>
<td>60</td>
</tr>
<tr>
<td>S2D</td>
<td>120</td>
<td>99</td>
<td>47</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>3-WAY/3-WAY</td>
<td>PNEUMATIC/</td>
<td>MANUAL</td>
<td>SIZE (inches)</td>
</tr>
<tr>
<td></td>
<td>3-WAY</td>
<td>PNEUMATIC/</td>
<td>DDC</td>
<td>MANUAL</td>
</tr>
</tbody>
</table>

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2.6 Provide and install new air temperature sensors. For temperature sensor designation and count see Table 2B.

Table 2B: Air Temperature Sensor List

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1D</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S2D</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2.7 Program the economizer operation as presented in Table 3.

Table 4: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

- AHU = air handling unit
- MAT = mixed air temperature (RA mixed with OA)
- OAT = outdoor air temperature
- RAT = return air temperature (returned to AHU from conditioned space)
- SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)
- OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

OAT > RAT
When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.6 Commission the operation of all the newly installed components.

2.7 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

**Task 3: Install Measure M2 AHU Schedule Optimization**

This measure consists of modifying operation schedules of the two air handlers (S1D and S2D) and three AC units (AC1D, AC2D, and AC3D) to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation.

All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 4. This can be accomplished at the EMS level in coordination with campus staff.

3.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

3.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

3.4 Commission the proposed schedule and set-back operation.
**Table 4: Proposed HVAC Schedules**

<table>
<thead>
<tr>
<th></th>
<th>S1D</th>
<th>S2D</th>
<th>AC1D</th>
<th>AC2D</th>
<th>AC3D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon-Fri</td>
<td>6:00 AM to 10:00 PM</td>
<td>6:00 AM to 10:00 PM</td>
<td>TBD - Was off during trending in September.</td>
<td>TBD - Was off during trending in September.</td>
<td>6:00 AM to 10:00 PM</td>
</tr>
<tr>
<td>Sat</td>
<td>6:00 AM to 5:00 PM</td>
<td>6:00 AM to 5:00 PM</td>
<td>6:00 AM to 5:00 PM</td>
<td>6:00 AM to 5:00 PM</td>
<td></td>
</tr>
<tr>
<td>Sun</td>
<td>8:00 AM to 12:00 PM</td>
<td>8:00 AM to 12:00 PM</td>
<td>8:00 AM to 12:00 PM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Task 4: Produce Measure Commissioning Documentation**

4.1 Contractor will commission the operation of measures M1 and M2 to insure that the systems are operating as described in this scope of work.

   4.1.1 Perform Functional testing and trend review to commission the systems.

4.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

   4.2.1 M1 Air Economizer Optimization

   4.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

   1. OAT
   2. RAT
   3. MAT
   4. SAT
   5. Economizer Position

   4.2.1.2 Provide a graph (Graph Name – Merritt Building D M1-1), with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

   4.2.1.3 Provide a graph (Graph Name - Merritt Building D M1-2), with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

4.2.2 M2 AHU Schedule Optimization

   4.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

   1. SF Status
   2. EF Status (S1D and S2D only)
4.2.2.2 Provide a graph (Graph Name - Merritt Building D M2-1), for each AHU and AC Unit, with at least one (1) week of data showing SF Status and RF Status on the Y-axis and Time (hourly) on the X-axis.

Task 5  Develop Measure Persistence Reports

5.1 Trends will be created for the parameters in Table 5. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 5: Points to be Trended

<table>
<thead>
<tr>
<th>EMS Trends</th>
<th>OAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>Economizer Position</th>
<th>Heating Valve % Open</th>
<th>Supply Fan Status</th>
<th>Exhaust Fan Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>S1D</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>S2D</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>AC1D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC2D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC3D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total EMS Points</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

5.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

Merritt Building D M1-1
Merritt Building D M1-2
Merritt Building D M2-1
Laney College: Theater
MBCx AHU Optimization

**General Description**
Optimize the energy use of the air handling units (AHU) serving the Theater at Laney College.

**Contractor Requirements**
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

**Special Requirements**
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

**Schedule**
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

**Purpose**
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Replacement of existing outdoor air (OA), return air (RA), exhaust air (EA) dampers where applicable as indicated in the scope of work below.
- Replacement of the existing pneumatic damper actuators with electronic actuators where applicable as indicated in the scope of work below.
- Replacement of the existing pneumatic/manual chilled water and heating hot water valves with electronic valves where applicable as indicated in the scope of work below.
- Replacement/installation of the outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors where applicable as indicated in the scope of work below.
- System commissioning is required for all systems included in this scope of work.
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>Supply Air Temperature Reset</td>
</tr>
<tr>
<td>M3</td>
<td>AHU Schedule Optimization</td>
</tr>
<tr>
<td>M4</td>
<td>Restore VFD Modulating Operation</td>
</tr>
<tr>
<td>M5</td>
<td>Demand Controlled Ventilation</td>
</tr>
</tbody>
</table>

Scope of Work
The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1  Produce Design Drawings
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

Task 2  Install Measure M1 Air Economizer Optimization
The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The systems included in the measure scope are SF-1 and SF-2 located on the fourth floor of the Theater. The tasks listed below outline the scope for this measure.

2.1 Remove existing air dampers and associated pneumatic damper actuators.

2.2 Remove existing air temperature sensors.

2.3 Provide and install new air dampers and new electronic damper actuators. For damper nominal sizes see Table 2. Contractor must site verify damper opening sizes before ordering dampers.

Table 2: Existing AHU Components

<table>
<thead>
<tr>
<th>NOMINAL OPENING FOR DAMPERS (Inches)</th>
<th>DAMPER ACTUATOR INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>OA</td>
</tr>
<tr>
<td>SF-1</td>
<td>48</td>
</tr>
<tr>
<td>SF-2</td>
<td>40</td>
</tr>
</tbody>
</table>
2.4 Provide and install new air temperature sensors. For temperature sensor designation and count see Table 2A.

### Table 2A: Air Temperature Sensor List

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SF-2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2.5 Program the economizer operation as presented in the Table 3.

### Table 3: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
</tbody>
</table>

Definitions:
- **AHU** = air handling unit
- **MAT** = mixed air temperature (RA mixed with OA)
- **OAT** = outdoor air temperature
- **RAT** = return air temperature (returned to AHU from conditioned space)
- **SAT** = supply air temperature (supplied to conditioned space as it is leaving the AHU)
- **OAF** = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.
SAT < OAT < RAT

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

OAT < SAT

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.6 Commission the operation of all the newly installed components.

2.7 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

Task 3 Install Measure M2 Supply Air Temperature Reset

The intent of this measure is to modify the existing control logic of the two air handlers (SF-1, SF-2) in order to fine-tune the existing Supply Air Temperature (SAT) reset strategy to minimize the AHUs cooling and heating energy use at partial load conditions. The tasks listed below outline the scope for this measure.

3.1 Revise the control logic to reset the SAT setpoint. The SAT setpoint shall change linearly as a function of OAT between listed OAT limits shown in Table 4 as a starting point.

<table>
<thead>
<tr>
<th>OAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>75°</td>
<td>60°</td>
</tr>
<tr>
<td>60°</td>
<td>64°</td>
</tr>
</tbody>
</table>

Table 4 shows target SAT reset limits. The actual reset limits will be determined in the field by testing the limits of each AHU to find the optimum reset schedule for each unit.

3.2 Commission SAT reset strategy.

3.3 After commissioning is completed the contractor is to observe the building conditions and optimize the reset strategy listed in Table 4 while making sure loads are satisfied. The optimization period should be at least three (3) days. The SAT temperatures for the reset strategy may be able to be widened to increase energy savings. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible.
Task 4. Install Measure M3 AHU Schedule Optimization

This measure consists of modifying operation schedules of the two air handlers (SF-1, SF-2) to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

4.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 5. This can be accomplished at the EMS level in coordination with campus staff.

4.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

4.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

4.4 Commission the proposed schedule and set-back operation.

Table 5: Initial Proposed HVAC Schedules

<table>
<thead>
<tr>
<th></th>
<th>SF-1</th>
<th>SF-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon-Fri</td>
<td>6:00 AM to 10:00 PM</td>
<td>6:00 AM to 10:00 PM</td>
</tr>
<tr>
<td>Sat</td>
<td>6:00 AM to 5:00 PM</td>
<td>6:00 AM to 5:00 PM</td>
</tr>
<tr>
<td>Sun</td>
<td>8:00 AM to 12:00 PM</td>
<td>8:00 AM to 12:00 PM</td>
</tr>
</tbody>
</table>

Task 5 Install Measure M4 Restore VFD Modulating Operation

The intent of this measure is to regain control of the SF-1 and SF-2 Supply and Return Fans’ VFDs which had been connected to the EMS and are not currently modulating. The measure will reprogram the VFD control as necessary.

Please note that ultimately SF-1 will be on demand controlled ventilation as described in M5. The goal for M4 is to get both AHUs modulating and to get SF-2 under an appropriate control sequence.

The tasks listed below outline the scope for this measure.

5.1 Install a new static pressure sensor on SF-1 and SF-2.

5.1.1. The existing sensor may be unreliable as it shows very low values of 0.5 in H2O. Investigation may show that it can be made operational.

5.1.2 If it is to be replaced, contractor to determine the optimal location for the sensor. Preferred location is 2/3 down the length of the duct.

5.2 Re-establish operation of VFDs from the control system.

5.3 Options for control:
5.3.1 **Static Pressure.** If field conditions indicate that the zones’ VAV boxes function well and static pressure will provide adequate control and modulation of the VFDs, a static pressure setpoint can be used to control VFD speeds.

5.3.2 **Load.** Modify the control logic for the VFDs to modulate as a function of load which will be based on the RAT. The operation is shown in Table 6.

**Table 6: Proposed VFD Control Based on Load**

<table>
<thead>
<tr>
<th>Mode</th>
<th>RAT Setpoint (Initial)</th>
<th>VFD Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating or Deadband</td>
<td>72</td>
<td>Minimum The minimum speed shall be optimized during the observation period. 30% speed can be used as a starting point.</td>
</tr>
<tr>
<td>Cooling</td>
<td>72</td>
<td>Minimum The VFD speed shall change linearly as a function of the RAT.</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>Maximum</td>
</tr>
</tbody>
</table>

5.4 Commission VFD modulating control strategy.

5.5 After commissioning is completed the contractor must observe the building conditions and optimize the VFD speed while making sure loads are satisfied. The optimization period should be at least three (3) days. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible. The setpoints will need to be adjusted in order to meet the following criteria.

5.5.1 The space is being heated adequately at the minimum speed.

5.5.2 The required ventilation air is being supplied to the space at all conditions while maintaining the lowest possible fan speed.

**Task 6 Install Measure M5 Demand Controlled Ventilation**

The intent of this measure is to reduce the SF-1 energy use when the theater is not occupied or has reduced occupancy. The tasks listed below outline the scope for this measure.

6.1 Install new CO₂ sensors in the theater and any other spaces served by SF-1.

6.1.1 Contractor to determine the number of CO₂ sensors required by code and optimal placement. It may be possible to place a single sensor in the return air duct.

6.2 Contractor to implement sequence for demand controlled ventilation.

6.2.1 Contractor to determine the outdoor air required when the space is vacant. This is sometimes called the “Area outdoor airflow rate”. It is based on the area of the space.
6.2.2 Contractor to determine the “Full outdoor airflow rate”. It is based on the maximum occupancy.

6.2.3 Contractor to determine CO₂ setpoint based on occupancy.

6.2.4 During the scheduled hours the fan speed should be set to provide at least the Area outdoor airflow rate. Otherwise, the fan speed will be controlled based on the CO₂ setpoint. The flow should approximately reach the full outdoor airflow rate when the space is at maximum occupancy or until more cooling is needed.

6.3 Commission demand controlled ventilation control strategy.

**Task 7 Produce Measure Commissioning Documentation**

7.1 Contractor will commission the operation of measures M1, M2, M3, M4 and M5 to insure that the systems are operating as described in this scope of work.

7.1.1 Perform Functional testing and trend review to commission the systems.

7.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

7.2.1 M1 Air Economizer Optimization

7.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

   1. OAT
   2. RAT
   3. MAT
   4. SAT
   5. Economizer position

7.2.1.2 Provide a graph (Graph Name - Laney Theater M1-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

7.2.1.3 Provide a graph (Graph Name - Laney Theater M1-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

7.2.2 M2 Supply Air Temperature Reset

7.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.
1. Chilled Water Valve position
2. SAT
3. SAT Setpoint
4. OAT

7.2.2.2 Provide a graph (Graph Name - Laney Theater M2-1), for each AHU, with at least one (1) week of data showing the above points as a function of OAT, where Chilled Water Valve position, SAT, and SAT setpoint are plotted on the Y-axis and OAT is plotted on the X-axis.

7.2.2.3 Provide a graph (Graph Name - Laney Theater M2-2), for each AHU, with at least one (1) week of data showing Chilled Water Valve position, SAT, SAT setpoint and OAT on the Y-axis and Time (hourly) on the X-axis.

7.2.3 M3 AHU Schedule Optimization
7.2.3.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.
   1. SF Status
   2. RF Status

7.2.3.2 Provide a graph (Graph Name - Laney Theater M3-1), for each AHU, with at least one (1) week of data showing SF Status and RF Status on the Y-axis and Time (hourly) on the X-axis.

7.2.4 M4 Restore VFD Modulating Operation
7.2.4.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.
   1. SF VFD Speed
   2. RF VFD Speed
   3. Static Pressure
   4. RAT
   5. Depending on control strategy:
      a. Static Pressure setpoint
      Or
      a. RAT setpoint for VFD operation
      b. VFD Minimum Speed setpoint
      c. VFD Maximum Speed setpoint

7.2.4.2 Provide a graph (Graph Name - Laney Theater M4-1), for each AHU, with at least one (1) week of data showing SF VFD Speed, RF VFD Speed, Static Pressure and RAT
on the Y-axis and either Static Pressure or RAT, depending on the implemented control strategy, on the X-axis.

7.2.4.3 Provide a graph (Graph Name - Laney Theater M4-2), for each AHU, with at least one (1) week of data showing SF VFD Speed, RF VFD Speed, Static Pressure and RAT on the Y-axis and Time (hourly) on the X-axis.

7.2.5 M5 Demand Controlled Ventilation

7.2.5.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF VFD Speed  
2. RF VFD Speed  
3. Static Pressure  
4. CO₂

7.2.5.2 Provide a graph (Graph Name - Laney Theater M5-1), for SF-1, with at least one (1) week of data showing SF VFD Speed, RF VFD Speed, Static Pressure and CO₂ on the Y-axis and Time (hourly) on the X-axis.

Task 8 Develop Measure Persistence Reports

8.1 Trends will be created for the parameters in Table 7. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 7: Points to be Trended

<table>
<thead>
<tr>
<th>System</th>
<th>Site</th>
<th>SF-1</th>
<th>SF-2</th>
<th>Total EMS Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT</td>
<td>SAT</td>
<td>SAT SP</td>
<td>RAT</td>
<td>MAT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Total EMS Points 24
8.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Laney Theater M1-1
- Laney Theater M1-2
- Laney Theater M2-1
- Laney Theater M2-2
- Laney Theater M3-1
- Laney Theater M4-1
- Laney Theater M4-2
- Laney Theater M5-1
Laney College: Library
MBCx AHU Optimization

**General Description**
Optimize the energy use of the air handling units (AHU) serving the Library at Laney College.

**Contractor Requirements**
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

**Special Requirements**
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

**Schedule**
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

**Purpose**
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:
- Replacement of existing outdoor air (OA), return air (RA), exhaust air (EA) dampers where applicable as indicated in the scope of work below.
- Replacement of the existing pneumatic damper actuators with electronic actuators where applicable as indicated in the scope of work below.
- Replacement of the existing pneumatic/manual chilled water and heating hot water valves with electronic valves where applicable as indicated in the scope of work below.
- Replacement/installation of the outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors where applicable as indicated in the scope of work below.
- System commissioning is required for all systems included in this scope of work.
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>Supply Air Temperature Reset</td>
</tr>
<tr>
<td>M3</td>
<td>AHU Schedule Optimization</td>
</tr>
<tr>
<td>M4</td>
<td>Restore VFD Modulating Operation</td>
</tr>
</tbody>
</table>

Scope of Work
The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1 Produce Design Drawings
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

Task 2 Install Measure M1 Air Economizer Optimization
The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The systems included in the measure scope are SF-1 and SF-2 in the basement of the library. The tasks listed below outline the scope for this measure.

2.1 Remove existing air dampers and associated pneumatic damper actuators.

2.2 Remove existing air temperature sensors.

2.3 Provide and install new air dampers and new electronic damper actuators. For damper nominal sizes see Table 2. Contractor must site verify damper opening sizes before ordering dampers.

Table 2: Existing AHU Components

<table>
<thead>
<tr>
<th>System</th>
<th>NOMINAL OPENING FOR DAMPERS (Inches)</th>
<th>DAMPER ACTUATOR INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OA</td>
<td>RA</td>
</tr>
<tr>
<td>SF-1</td>
<td>79</td>
<td>130</td>
</tr>
<tr>
<td>SF-2</td>
<td>79</td>
<td>119</td>
</tr>
</tbody>
</table>
2.4 Provide and install new air temperature sensors. For temperature sensor designation and count see Table 2A.

Table 2A: Air Temperature Sensor List

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SF-2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2.5 Program the economizer operation as presented in the Table 3.

Table 3: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

AHU = air handling unit

MAT = mixed air temperature (RA mixed with OA)

OAT = outdoor air temperature

RAT = return air temperature (returned to AHU from conditioned space)

SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)

OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

OAT > RAT

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.
SAT < OAT < RAT

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

OAT < SAT

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.6 Commission the operation of all the newly installed components.

2.7 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

Task 3  Install Measure M2 Supply Air Temperature Reset

The intent of this measure is to modify the existing control logic of the two air handlers (SF-1, SF-2) in order to fine-tune the existing Supply Air Temperature (SAT) reset strategy to minimize the AHUs cooling and heating energy use at partial load conditions. The tasks listed below outline the scope for this measure.

3.1 Revise the control logic to reset the SAT setpoint. The SAT setpoint shall change linearly as a function of OAT between listed OAT limits shown in Table 4 as a starting point.

Table 4: Initial SAT Reset Limits

<table>
<thead>
<tr>
<th>OAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>75°</td>
<td>60°</td>
</tr>
<tr>
<td>60°</td>
<td>64°</td>
</tr>
</tbody>
</table>

Table 4 shows target SAT reset limits. The actual reset limits will be determined in the field by testing the limits of each AHU to find the optimum reset schedule for each unit.

3.2 Commission SAT reset strategy.

3.3 After commissioning is completed the contractor is to observe the building conditions and optimize the reset strategy listed in Table 4 while making sure loads are satisfied. The optimization period should be at least three (3) days. The SAT temperatures for the reset strategy may be able to be widened to increase energy savings. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible.
Task 4. Install Measure M3 AHU Schedule Optimization

This measure consists of modifying operation schedules of the two air handlers (SF-1, SF-2) to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

4.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 5. This can be accomplished at the EMS level in coordination with campus staff.

4.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

4.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

4.4 Commission the proposed schedule and set-back operation.

Table 5: Initial Proposed HVAC Schedules

<table>
<thead>
<tr>
<th>Proposed Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-1</td>
</tr>
<tr>
<td>Mon-Fri</td>
</tr>
<tr>
<td>Sat</td>
</tr>
<tr>
<td>Sun</td>
</tr>
</tbody>
</table>

Task 5 Install Measure M4 Restore VFD Modulating Operation

The intent of this measure is to regain control of the SF-1 and SF-2 Supply and Return Fans’ VFDs which had been connected to the EMS and are not currently modulating. The measure will reprogram the VFD control as necessary. The tasks listed below outline the scope for this measure.

5.1 Install a new static pressure sensor on SF-2 only (SF-1 static pressure sensor appears reliable).

5.1.1 The existing sensor may be unreliable as it shows very low values of 0.2 in H2O. Investigation may show that it can be made operational.

5.1.2 If it is to be replaced, contractor to determine the optimal location for the sensor. Preferred location is 2/3 down the length of the duct.

5.2 Re-establish operation of VFDs from the control system.

5.3 Options for control:

5.3.1 Static Pressure. If field conditions indicate that the zones’ VAV boxes function well and static pressure will provide adequate control and modulation of the VFDs, a static pressure setpoint can be used to control VFD speeds.
5.3.2 **Load.** Modify the control logic for the VFDs to modulate as a function of load which will be based on the RAT. The operation is shown in Table 6.

**Table 6: Proposed VFD Control Based on Load**

<table>
<thead>
<tr>
<th>Mode</th>
<th>RAT Setpoint (Initial)</th>
<th>VFD Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating or Deadband</td>
<td>72</td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The minimum speed shall be optimized during the observation period. 30% speed can be used as a starting point.</td>
</tr>
<tr>
<td>Cooling</td>
<td>72</td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>Maximum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The VFD speed shall change linearly as a function of the RAT.</td>
</tr>
</tbody>
</table>

5.4 **Commission VFD modulating control strategy.**

5.5 After commissioning is completed the contractor must observe the building conditions and optimize the VFD speed while making sure loads are satisfied. The optimization period should be at least three (3) days. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible. The setpoints will need to be adjusted in order to meet the following criteria.

5.5.1 The space is being heated adequately at the minimum speed.

5.5.2 The required ventilation air is being supplied to the space at all conditions while maintaining the lowest possible fan speed.

**Task 6  Produce Measure Commissioning Documentation**

6.1 Contractor will commission the operation of measures M1, M2, M3 and M4 to insure that the systems are operating as described in this scope of work.

6.1.1 Perform Functional testing and trend review to commission the systems.

6.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

6.2.1 **M1 Air Economizer Optimization**

6.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer position
6.2.1.2 Provide a graph (Graph Name – Laney Library M1-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

6.2.1.3 Provide a graph (Graph Name – Laney Library M1-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

6.2.2 M2 Supply Air Temperature Reset

6.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

- Chilled Water Valve position
- SAT
- SAT Setpoint
- OAT

6.2.2.2 Provide a graph (Graph Name – Laney Library M2-1), for each AHU, with at least one (1) week of data showing the above points as a function of OAT, where Chilled Water Valve position, SAT, and SAT setpoint are plotted on the Y-axis and OAT is plotted on the X-axis.

6.2.2.3 Provide a graph (Graph Name – Laney Library M2-2), for each AHU, with at least one (1) week of data showing Chilled Water Valve position, SAT, SAT setpoint and OAT on the Y-axis and Time (hourly) on the X-axis.

6.2.3 M3 AHU Schedule Optimization

6.2.3.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

- SF Status
- RF Status

6.2.3.2 Provide a graph (Graph Name – Laney Library M3-1), for each AHU, with at least one (1) week of data showing SF Status and RF Status on the Y-axis and Time (hourly) on the X-axis.

6.2.4 M4 Restore VFD Modulating Operation

6.2.4.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

- SF VFD Speed
2. RF VFD Speed
3. Static Pressure
4. RAT
5. Depending on control strategy:
   a. Static Pressure setpoint
   Or
   a. RAT setpoint for VFD operation
   b. VFD Minimum Speed setpoint
   c. VFD Maximum Speed setpoint

6.2.4.2 Provide a graph (Graph Name – Laney Library M4-1), for each AHU, with at least one (1) week of data showing SF VFD Speed, RF VFD Speed, Static Pressure and RAT on the Y-axis and either Static Pressure or RAT, depending on the implemented control strategy, on the X-axis.

6.2.4.3 Provide a graph (Graph Name – Laney Library M4-2), for each AHU, with at least one (1) week of data showing SF VFD Speed, RF VFD Speed, Static Pressure and RAT on the Y-axis and Time (hourly) on the X-axis.

Task 7. Develop Measure Persistence Reports

7.1 Trends will be created for the parameters in Table 7. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 7: Points to be Tended

<table>
<thead>
<tr>
<th>System</th>
<th>EMS Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>OAT</td>
</tr>
<tr>
<td>SF-1LIB</td>
<td>1</td>
</tr>
<tr>
<td>SF-2LIB</td>
<td>1</td>
</tr>
<tr>
<td>Total EMS Points</td>
<td>25</td>
</tr>
</tbody>
</table>
7.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Laney Library M1-1
- Laney Library M1-2
- Laney Library M2-1
- Laney Library M2-2
- Laney Library M3-1
- Laney Library M4-1
- Laney Library M4-2
Laney College: Building A
MBCx AHU Optimization

General Description
Optimize the energy use of the air handling units (AHU) serving Building A at Laney College.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Replacement of existing outdoor air (OA), return air (RA), exhaust air (EA) dampers where applicable as indicated in the scope of work below.
- Replacement of the existing pneumatic damper actuators with electronic actuators where applicable as indicated in the scope of work below.
- Replacement of the existing pneumatic/manual chilled water and heating hot water valves with electronic valves where applicable as indicated in the scope of work below.
- Replacement/installation of the outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors where applicable as indicated in the scope of work below.
- System commissioning is required for all systems included in this scope of work.
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>

Scope of Work
The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1  Produce Design Drawings
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

Task 2  Install Measure M1 Economizer Optimization
The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The systems included in the measure scope are SF-1A, SF-2A, and SF-5A. The tasks listed below outline the scope for this measure.

2.1 Remove existing air dampers and associated pneumatic damper actuators.

2.2 Provide and install new air dampers and new electronic damper actuators. For damper nominal sizes see Table 2. Contractor must site verify damper opening sizes before ordering dampers.

Table 2: Existing AHU Components

<table>
<thead>
<tr>
<th>System</th>
<th>OA H</th>
<th>RA L</th>
<th>EA H</th>
<th>EA L</th>
<th>OA Type</th>
<th>RA Type</th>
<th>EA Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-1A</td>
<td>62</td>
<td>119</td>
<td>22</td>
<td>110</td>
<td>Pneumatic</td>
<td>Pneumatic</td>
<td>Pneumatic</td>
</tr>
<tr>
<td>SF-2A</td>
<td>62</td>
<td>119</td>
<td>22</td>
<td>110</td>
<td>Pneumatic</td>
<td>Pneumatic</td>
<td>Pneumatic</td>
</tr>
<tr>
<td>SF-5A</td>
<td>55</td>
<td>118</td>
<td>20</td>
<td>66</td>
<td>Pneumatic</td>
<td>Pneumatic</td>
<td>1</td>
</tr>
</tbody>
</table>

2.3 Provide and install new DDC Heating Hot Water valves for SF-1A, SF-2A and SF-5A.
2.4 Provide and install new air temperature sensors. For temperature sensor designation and count see Table 2A.

### Table 2A: Air Temperature Sensor List

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-1A</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SF-2A</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SF-5A</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2.5 Program the economizer operation as presented in the Table 3.

### Table 3: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:
- **AHU** = air handling unit
- **MAT** = mixed air temperature (RA mixed with OA)
- **OAT** = outdoor air temperature
- **RAT** = return air temperature (returned to AHU from conditioned space)
- **SAT** = supply air temperature (supplied to conditioned space as it is leaving the AHU)
- **OAF** = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**
When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**
During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.
OAT < SAT

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.6 Commission the operation of all the newly installed components.

2.7 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

Task 3  Install Measure M2 AHU Schedule Optimization

This measure consists of modifying operation schedules of the four air handlers (SF-1A, SF-2A, SF-5A and SF-6A) to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 4. This can be accomplished at the EMS level in coordination with campus staff.

3.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

3.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

3.4 Commission the proposed schedule and set-back operation.

<table>
<thead>
<tr>
<th>Task 4  Produce Measure Commissioning Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Contractor will commission the operation of measures M1 and M2 to insure that the systems are operating as described in this scope of work.</td>
</tr>
<tr>
<td>4.1.1 Perform Functional testing and trend review to commission the systems.</td>
</tr>
</tbody>
</table>
4.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

4.2.1 M1 Economizer Optimization

4.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer position

4.2.1.2 Provide a graph (Graph Name – Laney Building A M1-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

4.2.1.3 Provide a graph (Graph Name - Laney Building A M1-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

4.2.2 M2 AHU Schedule Optimization

4.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status
2. EF Status

4.2.2.2 Provide a graph (Graph Name - Building A M2-1), for each AHU, with at least one (1) week of data showing SF Status and EF Status on the Y-axis and Time (hourly) on the X-axis.

Task 5 Develop Measure Persistence Reports

5.1 Trends will be created for the parameters in Table 5. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.
Table 5: Points to be Tended

<table>
<thead>
<tr>
<th>EMS Trends</th>
<th>OAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>Economizer Position</th>
<th>SF VFD % Speed</th>
<th>Chilled Water Valve % Open</th>
<th>Heating Valve % Open</th>
<th>Static Pressure</th>
<th>Static Pressure SP</th>
<th>Supply Fan Status</th>
<th>Exhaust Fan Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF-1A</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>NA</td>
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</tr>
<tr>
<td>SF-2A</td>
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<td>1</td>
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<td>1</td>
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<td>NA</td>
<td>1</td>
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<td></td>
<td>8</td>
</tr>
<tr>
<td>SF-5A</td>
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<td>NA</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
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<td>1</td>
<td>1</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>SF-6A</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Total EMS Points</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

5.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

Laney Building A M1-1
Laney Building A M1-2
Laney Building A M2-1
SCOPE CHANGE - “Alerton” should be replaced with “Alerton or equivalent” for this Scope of Work

General Description
Optimize the energy use of the air handling units (AHU) serving the Library at the College of Alameda.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:
- Integration into a new Alerton control system.
- Functional testing and tuning of existing economizers.
- System commissioning is required for all systems included in this scope of work.
Scope of Work
The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1  Produce Design Drawings
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

Task 2  Install Measure M1 Installation of Alerton Controls
The intent of this measure is to integrate the units into the Alerton control system. The tasks listed below outline the scope for this measure.

2.1 Install six (6) Unit controllers, one on each of the roof top units (RTU), also referred to as AHU. Existing points are to be read on the new Alerton system.

2.2 Verify that each unit has outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors. If any are absent new sensors shall be installed and connected to the Alerton system. They will be used for analyzing the economizer operation.

2.3 Verify that the sensors mentioned above are calibrated.

2.4 Install one (1) main controller that will hold the “front end” for the new control system.

2.5 Develop graphics for controls. This will include at least one image for each unit (6 units) and one image for the building.

2.6 Develop control drawings that show the infrastructure used for controls.

2.7 Develop sequences of operation for each unit. Sequences shall meet requirements in measures below.
2.8 Commission the operation of all the newly installed components.
   2.8.1 Point to point tests
   2.8.2 Pre-Functional testing
   2.8.3 Functional testing
   2.8.4 Training of PCC staff for at least 8 hours.

Task 3  Install Measure M2 Air Economizer Optimization

The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The tasks listed below outline the scope for this measure.

3.1 Verify that the dampers and actuators are functional on each unit. These may require lubrication, mechanical troubleshooting, or control system troubleshooting.

3.2 Perform functional tests to observe if the economizer operation is as presented in the Table 3.

3.3 If the operation is not operating per Table 3 contractor to correct the operation.

   Table 2: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

- AHU = air handling unit
- MAT= mixed air temperature (RA mixed with OA)
- OAT = outdoor air temperature
- RAT = return air temperature (returned to AHU from conditioned space)
- SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)
- OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.
SAT < OAT < RAT
During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

OAT < SAT
When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

3.4 Commission the operation of all the newly installed components.

3.5 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

Task 4 Install Measure M3 Supply Air Temperature Reset
The intent of this measure is to modify the existing control logic of both AHUs in order to fine-tune the existing Supply Air Temperature (SAT) reset strategy to minimize the AHUs cooling and heating energy use at partial load conditions. The tasks listed below outline the scope for this measure.

4.1 Revise the control logic to reset the SAT set point. The SAT set point shall change linearly as a function of OAT between listed OAT limits shown in Table 4 as a starting point.

Table 3: Initial SAT Reset Limits

<table>
<thead>
<tr>
<th>OAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>75°</td>
<td>60°</td>
</tr>
<tr>
<td>60°</td>
<td>64°</td>
</tr>
</tbody>
</table>

Table 4 shows target SAT reset limits. The actual reset limits will be determined in the field by testing the limits of each AHU to find the optimum reset schedule for each unit.

4.2 Commission SAT reset strategy.

4.3 After commissioning is completed the contractor is to observe the building conditions and optimize the reset strategy listed in Table 4 while making sure loads are satisfied. The optimization period should be at least three (3) days. The SAT temperatures for the reset strategy may be able to be widened to increase energy savings. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible.
Task 5  Install Measure M4 AHU Schedule Optimization

This measure consists of modifying operation schedules of AHUs to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

5.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 5. This can be accomplished at the EMS level in coordination with campus staff.

5.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

5.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

5.4 Commission the proposed schedule and set-back operation.

<table>
<thead>
<tr>
<th>Table 4: Initial Proposed HVAC Schedules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed Schedule</td>
</tr>
<tr>
<td>RTUS1</td>
</tr>
<tr>
<td>Mon-Fri</td>
</tr>
<tr>
<td>Sat</td>
</tr>
<tr>
<td>Sun</td>
</tr>
</tbody>
</table>

Task 6  Produce Measure Commissioning Documentation

6.1 Contractor will commission the operation of measures M1, M2, M3 and M4 to insure that the systems are operating as described in this scope of work.

6.1.1 Perform Functional testing and trend review to commission the systems.

6.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

6.2.1 M1 Installation of Alerton Controls

6.2.1.1 Provide operations manual for the Alerton controls system showing the sequences of operation and wiring diagrams used for connecting Alerton boards to existing equipment.

6.2.1.2 Provide at least 4 hours of training to building staff on the new Alerton system.

6.2.2 M2 Air Economizer Optimization
6.2.2.1  Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer position

6.2.2.2  Provide a graph (Graph Name – Alameda Library M2-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

6.2.2.3  Provide a graph (Graph Name – Alameda Library M2-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

6.2.3  M3 Supply Air Temperature Reset

6.2.3.1  Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. Chilled Water Valve position
2. SAT
3. SAT Set point
4. OAT

6.2.3.2  Provide a graph (Graph Name – Alameda Library M3-1), for each AHU, with at least one (1) week of data showing the above points as a function of OAT, where Chilled Water Valve position, SAT, and SAT set point are plotted on the Y-axis and OAT is plotted on the X-axis.

6.2.3.3  Provide a graph (Graph Name – Alameda Library M3-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

6.2.4  M4 AHU Schedule Optimization

6.2.4.1  Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status
2. RF Status (where applicable)
6.2.4.2 Provide a graph (Graph Name – Alameda Library M4-1), for each AHU, with at least one (1) week of data showing SF Status and RF Status on the Y-axis and Time (hourly) on the X-axis.

Task 7 Develop Measure Persistence Reports

7.1 Trends will be created for the parameters in Table 7. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 5: Points to be Trended

<table>
<thead>
<tr>
<th>OAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>Economizer Position</th>
<th>Compressor 1 Status</th>
<th>Compressor 2 Status</th>
<th>Supply Fan Status</th>
<th>Return Fan Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>1</td>
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</tr>
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</tr>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

Total EMS Points 53
7.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Alameda Library M2-1
- Alameda Library M2-2
- Alameda Library M3-1
- Alameda Library M3-2
- Alameda Library M4-1
SCOPE CHANGE - Table 2 is updated Exhaust Air Damper Size is updated from 48 X 48 to 82 X 90 for SF-1B

General Description
Optimize the energy use of the air handling units (AHU) serving Building B at Laney College.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Replacement of existing outdoor air (OA), return air (RA), exhaust air (EA) dampers where applicable as indicated in the scope of work below.
- Replacement of the existing pneumatic damper actuators with electronic actuators where applicable as indicated in the scope of work below.
- Replacement of the existing pneumatic/manual chilled water and heating hot water valves with electronic valves where applicable as indicated in the scope of work below.
- Replacement/installation of the outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors where applicable as indicated in the scope of work below.
- System commissioning is required for all systems included in this scope of work.
**Table 1: Energy Efficiency Measure (EEM) Summary**

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>

**Scope of Work**
The scope of work for this building, as shown above in Table 1, is presented in detail below.

**Task 1  Produce Design Drawings**
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

**Task 2  Install Measure M1 Air Economizer Optimization**
The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The systems included in the measure scope are SF-1B and SF-2B. The tasks listed below outline the scope for this measure.

2.1 Remove existing air dampers and associated pneumatic damper actuators.

2.2 Remove existing air temperature sensors.

2.3 Provide and install new air dampers and new electronic damper actuators. For damper nominal sizes see Table 2. Contractor must site verify damper opening sizes before ordering dampers.

**Table 2: Existing AHU Components**

<table>
<thead>
<tr>
<th>System</th>
<th>OA</th>
<th>RA</th>
<th>EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>SF-1B</td>
<td>76</td>
<td>118</td>
<td>35</td>
</tr>
<tr>
<td>SF-2B</td>
<td>76</td>
<td>118</td>
<td>35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System</th>
<th>PNEUMATIC/ DDC</th>
<th>MANUAL</th>
<th>SIZE (Inches)</th>
<th>FLOW (gpm)</th>
<th>PD (In. H2O)</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-1B</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF-2B</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.4 Provide and install new DDC Heating Hot Water valves for SF-1B and SF-2B.
2.5 Provide and install new air temperature sensors. For temperature sensor designation and count see Table 2A.

Table 2A: Air Temperature Sensor List

<table>
<thead>
<tr>
<th>Temperature Sensors</th>
<th>System</th>
<th>OAT</th>
<th>MAT</th>
<th>RAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SF-1B</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>SF-2B</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2.6 Program the economizer operation as presented in the Table 3.

Table 3: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

AHU = air handling unit
MAT= mixed air temperature (RA mixed with OA)
OAT = outdoor air temperature
RAT = return air temperature (returned to AHU from conditioned space)
SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)
OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

OAT > RAT

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

SAT < OAT < RAT

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.
OAT < SAT

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.7 Commission the operation of all the newly installed components.

2.8 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

Task 3 Install Measure M2 AHU Schedule Optimization

This measure consists of modifying operation schedules of the two air handlers (SF-1B, SF-2B) to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

3.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 4. This can be accomplished at the EMS level in coordination with campus staff.

3.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

3.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

3.4. Commission the proposed schedule and set-back operation.

**Table 4: Initial Proposed HVAC Schedules**

<table>
<thead>
<tr>
<th>Proposed Schedule</th>
<th>SF-1B</th>
<th>SF-2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon-Fri</td>
<td>6:00 AM to 10:00 PM</td>
<td>6:00 AM to 10:00 PM</td>
</tr>
<tr>
<td>Sat</td>
<td>6:00 AM to 5:00 PM</td>
<td>6:00 AM to 5:00 PM</td>
</tr>
<tr>
<td>Sun</td>
<td>8:00 AM to 12:00 PM</td>
<td>8:00 AM to 12:00 PM</td>
</tr>
</tbody>
</table>

Task 4 Produce Measure Commissioning Documentation

4.1 Contractor will commission the operation of measures M1 and M2 to insure that the systems are operating as described in this scope of work.

4.1.1 Perform Functional testing and trend review to commission the systems.
4.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

4.2.1 M1 Air Economizer Optimization

4.2.1.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer position

4.2.1.2 Provide a graph (Graph Name - Laney Building B M1-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

4.2.1.3 Provide a graph (Graph Name - Laney Building B M1-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

4.2.2 M2 AHU Schedule Optimization

4.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status
2. EF Status

4.2.2.2 Provide a graph (Graph Name - Laney Building B M2-1), for each AHU, with at least one (1) week of data showing SF Status and EF Status on the Y-axis and Time (hourly) on the X-axis.

Task 5 Develop Measure Persistence Reports

5.1 Trends will be created for the parameters in Table 5. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.
### Table 5: Points to be Trended

<table>
<thead>
<tr>
<th>System</th>
<th>CAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>Economizer Position</th>
<th>Heating Valve % Open</th>
<th>Supply Fan Status</th>
<th>Exhaust Fan Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>SF-2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

Total EMS Points: 17

5.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Laney Building B M1-1
- Laney Building B M1-2
- Laney Building B M2-1
SCOPE CHANGE – Section 2.1 is changed as follows “Verify that the dampers and actuators are functional on each unit. These may require lubrication, mechanical troubleshooting, or control system troubleshooting” is removed and replaced with “Remove existing air dampers and associated pneumatic damper actuators. Provide and install new air dampers and new electronic damper actuators.”

General Description
Optimize the energy use of the air handling units (AHU) serving Building G at Laney College.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Functional testing and tuning of existing economizers.
- System commissioning is required for all systems included in this scope of work.
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M2</td>
<td>Supply Air Temperature Reset</td>
</tr>
<tr>
<td>M3</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>

Scope of Work
The scope of work for this building, as shown above in Table 1, is presented in detail below.

Task 1  Produce Design Drawings
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements

Task 2  Install Measure M1 Air Economizer Optimization
The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. This measure applies to AC1G only. The tasks listed below outline the scope for this measure.

2.1 Verify that the dampers and actuators are functional on each unit. These may require lubrication, mechanical troubleshooting, or control system troubleshooting. Remove existing air dampers and associated pneumatic damper actuators. Provide and install new air dampers and new electronic damper actuators.

2.2 Verify that the temperature sensors are calibrated (OAT, RAT, MAT, SAT).

2.3 Perform functional tests to observe if the economizer operation is as presented in the Table 3.

2.4 If the economizer operation is not functioning per Table 3 contractor to correct the operation.

Table 2: Economizer Damper Control Strategy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:
AHU = air handling unit
MAT = mixed air temperature (RA mixed with OA)
OAT = outdoor air temperature
RAT = return air temperature (returned to AHU from conditioned space)
SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)
OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.

**SAT < OAT < RAT**

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

2.5 Commission the operation of all the newly installed components.

2.6 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

**Task 3 Install Measure M2 Supply Air Temperature Reset**

The intent of this measure is to modify the existing control logic of AHUs in order to fine-tune the existing Supply Air Temperature (SAT) reset strategy to minimize the AHUs cooling and heating energy use at partial load conditions. There are four units included in this measure. The included units are SF1G, SF2G, SF3G, and AC1G. The tasks listed below outline the scope for this measure.

3.1 Revise the control logic to reset the SAT set point. The SAT set point shall change linearly as a function of OAT between listed OAT limits shown in Table 4 as a starting point.
Table 3: Initial SAT Reset Limits

<table>
<thead>
<tr>
<th>OAT</th>
<th>SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>75°</td>
<td>60°</td>
</tr>
<tr>
<td>60°</td>
<td>64°</td>
</tr>
</tbody>
</table>

Table 4 shows target SAT reset limits. The actual reset limits will be determined in the field by testing the limits of each AHU to find the optimum reset schedule for each unit.

3.2 Commission SAT reset strategy.

3.3 After commissioning is completed the contractor is to observe the building conditions and optimize the reset strategy listed in Table 4 while making sure loads are satisfied. The optimization period should be at least three (3) days. The SAT temperatures for the reset strategy may be able to be widened to increase energy savings. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible.

Task 4. Install Measure M3 AHU Schedule Optimization

This measure consists of modifying operation schedules of AHUs to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

4.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 5. This can be accomplished at the EMS level in coordination with campus staff.

4.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

4.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

4.4 Commission the proposed schedule and set-back operation.

Table 4: Initial Proposed HVAC Schedules

<table>
<thead>
<tr>
<th>SF1G</th>
<th>SF2G</th>
<th>SF3G</th>
<th>SF7G</th>
<th>SF8G</th>
<th>AC1G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon-Fri</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
</tr>
<tr>
<td>Sat</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
<td>7:00 AM to 6:00 PM</td>
</tr>
<tr>
<td>Sun</td>
<td>9:00 AM to 5:00 PM</td>
<td>9:00 AM to 5:00 PM</td>
<td>9:00 AM to 5:00 PM</td>
<td>9:00 AM to 5:00 PM</td>
<td>9:00 AM to 5:00 PM</td>
</tr>
</tbody>
</table>
Task 5  Produce Measure Commissioning Documentation

5.1 Contractor will commission the operation of measures M1, M2, and M3 to insure that the systems are operating as described in this scope of work.

5.1.1 Perform Functional testing and trend review to commission the systems.

5.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

5.2.2 M1 Air Economizer Optimization

5.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer position

5.2.2.2 Provide a graph (Graph Name – Laney Building G M1-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

5.2.2.3 Provide a graph (Graph Name – Laney Building G M1-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

5.2.3 M2 Supply Air Temperature Reset

5.2.3.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. Chilled Water Valve position
2. SAT
3. SAT Set point
4. OAT

5.2.3.2 Provide a graph (Graph Name – Laney Building G M2-1), for each AHU, with at least one (1) week of data showing the above points as a function of OAT, where Chilled Water Valve position, SAT, and SAT set point are plotted on the Y-axis and OAT is plotted on the X-axis.
5.2.3.3 Provide a graph (Graph Name – Laney Building G M2-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

5.2.4 M3 AHU Schedule Optimization

5.2.4.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status
2. RF or EF Status if applicable.

5.2.4.2 Provide a graph (Graph Name – Laney Building G M3-1), for each AHU, with at least one (1) week of data showing SF Status and RF Status on the Y-axis and Time (hourly) on the X-axis.

Task 6 Develop Measure Persistence Reports

6.1 Trends will be created for the parameters in Table 7. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

**Table 5: Points to be Trended**

<table>
<thead>
<tr>
<th>System</th>
<th>OAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>SF VFD % Speed</th>
<th>RF VFD % Speed</th>
<th>Chilled Water Valve % Open</th>
<th>Heating Valve % Open</th>
<th>Supply Fan Status</th>
<th>Return/Exhaust Fan Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF1G</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>SF2G</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>SF3G</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<td>SF7G</td>
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<td>1</td>
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<tr>
<td>SF8G</td>
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<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>AC1G</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

Total EMS Points 26
6.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

- Laney Building G M1-1
- Laney Building G M1-2
- Laney Building G M2-1
- Laney Building G M2-1
- Laney Building G M3-1
SCOPE CHANGE - “Alerton” should be replaced with “Alerton or equivalent” for this Scope of Work

General Description
Optimize the energy use of the air handling units (AHU) serving the Library at the College of Alameda.

Contractor Requirements
The contractor should have all required state licenses to perform work on air handling systems serving educational facilities.

Special Requirements
- Work should be performed to meet seismic code
- All mechanical work will be in accordance with ASHRAE and SMACNA standards
- Design work should meet the California and local codes
- The contractor will produce design drawings for owner approval before starting retrofit

Schedule
Work should be performed following the schedule required and approved by the owner. Contractor will propose a project schedule for review and approval by the owner within a week (seven calendar days) of contract award.

Purpose
The objective of this project is to implement the measures listed in Table 1. The execution of the measures listed will optimize the energy use of selected AHU systems serving the building.

In order for the measure scope listed below to be executed, the following changes to the Air Handling Systems will be made and are included in this scope of work. This includes the installation or repairs of the following:

- Integration into a new Alerton control system.
- Functional testing and tuning of existing economizers.
- System commissioning is required for all systems included in this scope of work.
Table 1: Energy Efficiency Measure (EEM) Summary

<table>
<thead>
<tr>
<th>EEM</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Installation of Alerton Controls</td>
</tr>
<tr>
<td>M2</td>
<td>Air Economizer Optimization</td>
</tr>
<tr>
<td>M3</td>
<td>Supply Air Temperature Reset</td>
</tr>
<tr>
<td>M4</td>
<td>AHU Schedule Optimization</td>
</tr>
</tbody>
</table>

**Scope of Work**
The scope of work for this building, as shown above in Table 1, is presented in detail below.

**Task 1  Produce Design Drawings**
Contractor will produce design drawings showing the proposed mechanical, electrical and control changes and the design drawings must be approved by owner before executing work.

Deliverable – Design drawings for proposed mechanical, electrical, and control changes, additions, and improvements.

**Task 2  Install Measure M1 Installation of Alerton Controls**
The intent of this measure is to integrate the units into the Alerton control system. The tasks listed below outline the scope for this measure.

2.1 Install six (6) Unit controllers, one on each of the roof top units (RTU), also referred to as AHU. Existing points are to be read on the new Alerton system.

2.2 Verify that each unit has outdoor air temperature (OAT), return air temperature (RAT), mixed air temperature (MAT), and supply air temperature (SAT) sensors. If any are absent new sensors shall be installed and connected to the Alerton system. They will be used for analyzing the economizer operation.

2.3 Verify that the sensors mentioned above are calibrated.

2.4 Install one (1) main controller that will hold the “front end” for the new control system.

2.5 Develop graphics for controls. This will include at least one image for each unit (6 units) and one image for the building.

2.6 Develop control drawings that show the infrastructure used for controls.

2.7 Develop sequences of operation for each unit. Sequences shall meet requirements in measures below.
2.8 Commission the operation of all the newly installed components.
   2.8.1 Point to point tests
   2.8.2 Pre-Functional testing
   2.8.3 Functional testing
   2.8.4 Training of PCC staff for at least 8 hours.

Task 3  Install Measure M2 Air Economizer Optimization

The intent of this measure is to optimize the operation of the economizer to minimize mechanical cooling and heating energy. The tasks listed below outline the scope for this measure.

3.1 Verify that the dampers and actuators are functional on each unit. These may require lubrication, mechanical troubleshooting, or control system troubleshooting.

3.2 Perform functional tests to observe if the economizer operation is as presented in the Table 3.

3.3 If the operation is not operating per Table 3 contractor to correct the operation.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT &gt; RAT</td>
<td>OA dampers to OAF minimum position; RA dampers to 1-OAF minimum position.</td>
</tr>
<tr>
<td>SAT &lt; OAT &lt; RAT</td>
<td>OA dampers to 100% open position; RA dampers to 100% closed position.</td>
</tr>
<tr>
<td>OAT &lt; SAT</td>
<td>Modulate OA and RA dampers to maintain MAT = SAT.</td>
</tr>
</tbody>
</table>

Definitions:

AHU = air handling unit
MAT = mixed air temperature (RA mixed with OA)
OAT = outdoor air temperature
RAT = return air temperature (returned to AHU from conditioned space)
SAT = supply air temperature (supplied to conditioned space as it is leaving the AHU)
OAF = outdoor air flow

The intent of the proposed economizer operation is to minimize or eliminate the AHU cooling and heating loads. The optimum performance of an Air Handling Unit can occur when the mixed air matches the supply air temperature. When ambient conditions make this possible the need for cooling and/or heating energy is eliminated.

**OAT > RAT**

When the outside air temperature is greater than that of the air returning from the building, the economizer damper should modulate to a minimum position, thereby minimizing the temperature differential and reducing the cooling load across the AHU’s cooling coils.
**SAT < OAT < RAT**

During this condition the economizer dampers are set such as to allow only outdoor air into the mixing plenum. Since the outdoor air temperature is less than the air returning from the building, this would be the most optimized operation possible for an AHU at moderate ambient conditions.

**OAT < SAT**

When the outdoor air temperature is below the AHU’s Supply Air Temperature there is no need for cooling. If the economizer was allowed to operate such that the mixed air is higher than the Supply Air temperature than an artificial cooling load would result, creating an unnecessary cooling demand, and an increase in the operation of the HVAC System’s cooling equipment. On the other hand, allowing the mixed air temperature to prematurely fall below the supply air temperature would create an artificial heating load though a proper mixture of outdoor and mixed air would be sufficient to produce the desired supply air temperature without any heating. The most optimal performance would be to modulate the economizer dampers so that there is no load at the coils, or MAT = SAT.

3.4 Commission the operation of all the newly installed components.

3.5 Commission the economizer operation per the control strategy shown in Table 3. Functional testing and trend review will be required.

**Task 4 Install Measure M3 Supply Air Temperature Reset**

The intent of this measure is to modify the existing control logic of both AHUs in order to fine-tune the existing Supply Air Temperature (SAT) reset strategy to minimize the AHUs cooling and heating energy use at partial load conditions. The tasks listed below outline the scope for this measure.

4.1 Revise the control logic to reset the SAT set point. The SAT set point shall change linearly as a function of OAT between listed OAT limits shown in Table 4 as a starting point.

\[
\begin{array}{|c|c|}
\hline
\text{OAT} & \text{SAT} \\
75^\circ & 60^\circ \\
60^\circ & 64^\circ \\
\hline
\end{array}
\]

*Table 3: Initial SAT Reset Limits*

*Table 4 shows target SAT reset limits. The actual reset limits will be determined in the field by testing the limits of each AHU to find the optimum reset schedule for each unit.*

4.2 Commission SAT reset strategy.

4.3 After commissioning is completed the contractor is to observe the building conditions and optimize the reset strategy listed in Table 4 while making sure loads are satisfied. The optimization period should be at least three (3) days. The SAT temperatures for the reset strategy may be able to be widened to increase energy savings. The AHU can be operated all hours during the optimization period in order to get the widest range of OAT possible.
Task 5  Install Measure M4 AHU Schedule Optimization

This measure consists of modifying operation schedules of AHUs to eliminate operation when the building is not occupied. All schedule changes will be coordinated with owner prior to implementation. The tasks listed below outline the scope for this measure.

5.1 Modify the weekly start/stop schedule per the proposed hours shown in Table 5. This can be accomplished at the EMS level in coordination with campus staff.

5.2 Program the AHU systems to turn on at night when the building space temperature falls below the space set-back temperature of 50°F. The heating system shall operate until the space temperature reaches 55°F or the scheduled occupied time is reached.

5.3 Program the holiday schedules with reduced, or off operation. Contractor shall consult owner for days and operation for the holidays.

5.4 Commission the proposed schedule and set-back operation.

Table 4: Initial Proposed HVAC Schedules

<table>
<thead>
<tr>
<th></th>
<th>RTUS1</th>
<th>RTUS2</th>
<th>RTUS3</th>
<th>RTUS4</th>
<th>RTUS5</th>
<th>RTUS6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposed Schedule</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mon-Fri</strong></td>
<td>7:00 AM to 8:00 PM</td>
<td>7:00 AM to 8:00 PM</td>
<td>7:00 AM to 8:00 PM</td>
<td>7:00 AM to 8:00 PM</td>
<td>7:00 AM to 8:00 PM</td>
<td>7:00 AM to 8:00 PM</td>
</tr>
<tr>
<td><strong>Sat</strong></td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td><strong>Sun</strong></td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
</tbody>
</table>

Task 6  Produce Measure Commissioning Documentation

6.1 Contractor will commission the operation of measures M1, M2, M3 and M4 to insure that the systems are operating as described in this scope of work.

6.1.1 Perform Functional testing and trend review to commission the systems.

6.2 Contractor will provide confirmation that systems are operating correctly on all AHUs listed in this scope of work.

6.2.1 M1 Installation of Alerton Controls

6.2.1.1 Provide operations manual for the Alerton controls system showing the sequences of operation and wiring diagrams used for connecting Alerton boards to existing equipment.

6.2.1.2 Provide at least 4 hours of training to building staff on the new Alerton system.

6.2.2 M2 Air Economizer Optimization
6.2.2.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. OAT
2. RAT
3. MAT
4. SAT
5. Economizer position

6.2.2.2 Provide a graph (Graph Name – Alameda Library M2-1), for each AHU, with at least one (1) week of data showing Economizer Position as function of OAT, where the Economizer Position is plotted on the Y-axis and OAT on the X-axis.

6.2.2.3 Provide a graph (Graph Name – Alameda Library M2-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

6.2.3 M3 Supply Air Temperature Reset

6.2.3.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. Chilled Water Valve position
2. SAT
3. SAT Set point
4. OAT

6.2.3.2 Provide a graph (Graph Name – Alameda Library M3-1), for each AHU, with at least one (1) week of data showing the above points as a function of OAT, where Chilled Water Valve position, SAT, and SAT set point are plotted on the Y-axis and OAT is plotted on the X-axis.

6.2.3.3 Provide a graph (Graph Name – Alameda Library M3-2), for each AHU, with at least one (1) week of data showing OAT, MAT, RAT, SAT, and economizer position vs. time, where OAT, MAT, RAT, SAT, and Economizer Position are plotted on the Y-axis and Time (hourly) is plotted on the X-axis.

6.2.4 M4 AHU Schedule Optimization

6.2.4.1 Provide at least one (1) week of post installation data in 15 minute intervals for the following points. Provide in csv format so that the data can be imported into Microsoft Excel.

1. SF Status
2. RF Status (where applicable)
6.2.4.2 Provide a graph (Graph Name – Alameda Library M4-1), for each AHU, with at least one (1) week of data showing SF Status and RF Status on the Y-axis and Time (hourly) on the X-axis.

Task 7 Develop Measure Persistence Reports

7.1 Trends will be created for the parameters in Table 7. The trends will be generated in 15-minute intervals and stored for a minimum of one (1) month. EMS/Reporting System will provide the CSV format as an option for data export.

Table 5: Points to be Trended

<table>
<thead>
<tr>
<th>System</th>
<th>Site</th>
<th>OAT</th>
<th>SAT</th>
<th>SAT SP</th>
<th>RAT</th>
<th>MAT</th>
<th>Economizer Position</th>
<th>Compressor 1 Status</th>
<th>Compressor 2 Status</th>
<th>Supply Fan Status</th>
<th>Return Fan Status</th>
<th>Total System Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTUS1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>RTUS2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>RTUS3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>RTUS4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>RTUS5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>RTUS6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

Total EMS Points | 53
7.2 Develop automated reporting function with the EMS that will produce all of the reports referenced above on bi-weekly (two-weeks) basis. The following reports will be created:

Alameda Library M2-1
Alameda Library M2-2
Alameda Library M3-1
Alameda Library M3-2
Alameda Library M4-1
<table>
<thead>
<tr>
<th>Building No.</th>
<th>Campus</th>
<th>Building Description</th>
<th>Square Footage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Merritt College</td>
<td>Merritt College - Building R</td>
<td>53,889</td>
</tr>
<tr>
<td>2</td>
<td>Merritt College</td>
<td>Merritt College - Building P</td>
<td>44,537</td>
</tr>
<tr>
<td>3</td>
<td>Merritt College</td>
<td>Merritt College - Building A</td>
<td>46,201</td>
</tr>
<tr>
<td>4</td>
<td>Merritt College</td>
<td>Merritt College - Building D</td>
<td>75,493</td>
</tr>
<tr>
<td>5</td>
<td>Laney College</td>
<td>Laney College - Theater</td>
<td>44,537</td>
</tr>
<tr>
<td>6</td>
<td>Laney College</td>
<td>Laney College – Building G</td>
<td>46,201</td>
</tr>
<tr>
<td>7</td>
<td>Laney College</td>
<td>Laney College - Library</td>
<td>75,493</td>
</tr>
<tr>
<td>8</td>
<td>Laney College</td>
<td>Laney College – Building A</td>
<td>53,889</td>
</tr>
<tr>
<td>9</td>
<td>Laney College</td>
<td>Laney College - Building B</td>
<td>43,002</td>
</tr>
<tr>
<td>10</td>
<td>Laney College</td>
<td>Laney College - Admin Tower</td>
<td>53,988</td>
</tr>
<tr>
<td>11</td>
<td>Laney College</td>
<td>Laney College - Building F</td>
<td>34,084</td>
</tr>
<tr>
<td>12</td>
<td>College of Alameda</td>
<td>Library</td>
<td>41,536</td>
</tr>
<tr>
<td>13</td>
<td>District</td>
<td>District Administrative Center</td>
<td>26,300</td>
</tr>
<tr>
<td>14</td>
<td>District</td>
<td>Physical Plant</td>
<td>41,500</td>
</tr>
</tbody>
</table>
### ELECTRIC METERS

<table>
<thead>
<tr>
<th>MARK NUMBER</th>
<th>MANUFACTURER</th>
<th>CTs MODEL</th>
<th>CTs QUANTITY</th>
<th>VOLTAGE LEADS MODEL</th>
<th>VOLTAGE LEADS QUANTITY</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EM-1</td>
<td>SETRA</td>
<td>SPP-E-D</td>
<td>2</td>
<td>CT-PF-24</td>
<td>SPP-ACC-FUSE-208</td>
<td>1 SET OF 3 METER SHALL BE BACNET COMPATIBLE</td>
</tr>
</tbody>
</table>

### GAS METER

<table>
<thead>
<tr>
<th>MARK NUMBER</th>
<th>MANUFACTURER</th>
<th>GAS MODEL</th>
<th>QTY.</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM-1</td>
<td>SIERRA</td>
<td></td>
<td>2</td>
<td>8405-NAA-L05-M0-E2-V4-D0-B PULSE METER TO BE INSTALLED DOWNSTREAM OF PRESSURE REGULATOR AND SHUT OFF VALVE</td>
</tr>
</tbody>
</table>

### BTU METERS

<table>
<thead>
<tr>
<th>MARK NUMBER</th>
<th>MANUFACTURER</th>
<th>BTU METER MODEL</th>
<th>BTU METER QUANTITY</th>
<th>FLOW METER MODEL</th>
<th>FLOW METER QUANTITY</th>
<th>LINE SIZE (IN)</th>
<th>TEMPERATURE SENSORS MODEL</th>
<th>TEMPERATURE SENSORS QUANTITY</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTUM-1</td>
<td>ONICON</td>
<td>SYSTEM-10 BACNET MS/TP</td>
<td>2</td>
<td>F-1200</td>
<td>2</td>
<td>2.5</td>
<td>BATH CALIBRATED AND MATCHED</td>
<td>4 PROVIDE FLOW AND TEMPERATURE SENSOR INSTALLATION KITS FOR HOT TAP INSTALLATION</td>
<td></td>
</tr>
<tr>
<td>BTUM-2</td>
<td>ONICON</td>
<td>SYSTEM-10 BACNET MS/TP</td>
<td>11</td>
<td>F-1200</td>
<td>11</td>
<td>3</td>
<td>BATH CALIBRATED AND MATCHED</td>
<td>22 PROVIDE FLOW AND TEMPERATURE SENSOR INSTALLATION KITS FOR HOT TAP INSTALLATION</td>
<td></td>
</tr>
<tr>
<td>BTUM-3</td>
<td>ONICON</td>
<td>SYSTEM-10 BACNET MS/TP</td>
<td>7</td>
<td>F-1200</td>
<td>7</td>
<td>4</td>
<td>BATH CALIBRATED AND MATCHED</td>
<td>14 PROVIDE FLOW AND TEMPERATURE SENSOR INSTALLATION KITS FOR HOT TAP INSTALLATION</td>
<td></td>
</tr>
<tr>
<td>BTUM-4</td>
<td>ONICON</td>
<td>SYSTEM-10 BACNET MS/TP</td>
<td>1</td>
<td>F-1200</td>
<td>1</td>
<td>5</td>
<td>BATH CALIBRATED AND MATCHED</td>
<td>2 PROVIDE FLOW AND TEMPERATURE SENSOR INSTALLATION KITS FOR HOT TAP INSTALLATION</td>
<td></td>
</tr>
<tr>
<td>BTUM-5</td>
<td>ONICON</td>
<td>SYSTEM-10 BACNET MS/TP</td>
<td>1</td>
<td>F-1200</td>
<td>1</td>
<td>6</td>
<td>BATH CALIBRATED AND MATCHED</td>
<td>2 PROVIDE FLOW AND TEMPERATURE SENSOR INSTALLATION KITS FOR HOT TAP INSTALLATION</td>
<td></td>
</tr>
</tbody>
</table>
ALAMEDA LIBRARY ROOF PLAN

NOT TO SCALE

1 PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2 POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3 TIE BTU METER TO EMS.
PARTIAL 1ST FLOOR PLAN - BUILDING D

NOT TO SCALE

**SHEET NOTES:**

1. PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER. HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2. POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3. TIE BTU METER TO EMS.
Sheet Notes:

1. Provide and install BTU meter including (2) matched temperature sensors (1) Flow meter, hot tap temp sensors and flow meters into piping. Site verify line size before ordering flow meter.


3. Tie BTU meter to EMS.

Partial Site Plan - Merritt College

Mechanical Room Q108

Not To Scale
PHYSICAL PLANT PARTIAL PLAN

1. NOT USED.
2. NOT USED.
3. NOT USED.
4. INSTALL ELECTRIC METER EM-1, TO MEASURE ELECTRIC ENERGY USE OF (E) MAIN SWITCH BOARD.
5. TIE ELECTRIC METER TO EMS.
1. PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2. POWER BTU=M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3. TIE BTU METER TO EMS.

4. INSTALL ELECTRIC METER EM--1, TO MEASURE ELECTRIC ENERGY USE OF (E) MAIN SWITCH BOARD.

5. TIE ELECTRIC METER TO EMS.
1. PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2. POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3. TIE BTU METER TO EMS.

1ST FLOOR PLAN - BUILDING B

NOT TO SCALE
1 PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2 POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3 TIE BTU METER TO EMS.
LIBRARY 1ST FLOOR PLAN

NOT TO SCALE

1 PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2 POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3 TIE BTU METER TO EMS.
THEATER 1ST FLOOR PLAN

1 PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2 POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3 TIE BTU METER TO EMS.
1 PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2 POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3 TIE BTU METER TO EMS.

4 ALTERNATE LOCATIONS ARE ACCEPTABLE.
1 PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2 POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3 TIE BTU METER TO EMS.
1 PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (8) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2 POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3 TIE BTU METER TO EMS.
SHEET NOTES:

1. PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER. HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2. POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3. TIE BTU METER TO EMS.
1 PROVIDE AND INSTALL BTU METER INCLUDING (2) MATCHED TEMPERATURE SENSORS (1) FLOW METER, HOT TAP TEMP SENSORS AND FLOW METERS INTO (E) PIPING. SITE VERIFY LINE SIZE BEFORE ORDERING FLOW METER.

2 POWER BTU-M AND COMPONENTS FROM NEAREST 24 VOLT SOURCE.

3 TIE BTU METER TO EMS.
Sheet Notes:

1. Provide and install BTU meter including (2) matched temperature sensors (1) flow meter, hot tap temp sensors and flow meters into (E) piping. Site verify line size before ordering flow meter.


3. Tie BTU meter to EMS.
General Description
Install electric and BTU meters required to comply with the Monitoring Based Commissioning (MBCx) program. The project scope involves the installation of new meters, calibration of existing electric meters and provision of a new front end to the existing Energy Management System (EMS).

Purpose
The project intent is to provide whole-building metering to comply with the MBCx Program metering requirements. The MBCx “Program requires Whole-Building energy monitoring” (MBCx Project Guidelines Minimum Requirements dated Aug 2013, P2). In this case the metering is required includes electric, cooling and heating energy meters. The implementation of this project includes the execution of the three components listed below:

A. Install new BTU, natural gas and electric meters
B. Calibrate Existing Electric Meters
C. Provide and install a new front end to the existing EMS to connect all the existing and new meters

Scope of Work
This section outlines the major task required for the three project components listed above.

A. Install new BTU, natural gas, and electric meters. The Table 1.0 shows the new Electric Meter count for buildings included in the project scope.

Table 1.0
PCC Existing and New Meters Per Building
This project component installation includes the execution of the following major tasks:

a. Provide and install (2) new electric meter. (For meter location, model number and installation instructions see project drawings. For meter specifications see Appendix A)

b. Provide and install (20) new BTU and (1) natural gas meters. (For BTU and natural gas meter location, model number and installation instructions see project drawings. For meter specifications see Appendix A)

c. Calibrate and commission the operation of all the new meters.

B. Calibrate Existing Electric Meters. The Table 1.0 shows the existing electric meters and corresponding electric panel.

This project component installation includes the execution of the following major tasks:

a. Coordinate with site personal a schedule to open the electric panels for each existing electric meter.

b. Calibrate each existing meter to insure accurate measurements

c. Prepare meters for connection to new EMS front end
C. **Provide and install a new front end to the existing EMS to connect all the existing and new meters**

This project component installation includes the execution of the following major tasks:

a. Provide and install a new EMS front end (See Appendix B for EMS specifications)
b. Connect all the new and existing meters to the new EMS front end.
c. Provide all programming necessary to configure the set up of metering trends and data storage.
d. Commission the operation of the EMS metering trends, metering reports and data collection
e. Train Facility operators to use the new energy monitoring system.
APPENDIX A
ELECTRIC AND BTU METER SPECIFICATIONS

A.1 ELECTRIC METERS

The electric meters shall be 0.5% revenue grade accurate; field selected Bacnet MS/TP ethernet port with flexible CTs and fused voltage leads.

The base meter model selected is shown below:

Manufacturer: Setra (Power Patrol)

Meter Model SPP-E-D

Flexible CTs CT-PF-24 (Important to reduce installation time)

Voltage Leads SPP-ACC-FUSE-208 VAC

Equivalent meters shall meet or exceed the key parameters and features of the product described in this section.

A.2 BTU METERS

The entire Energy Measurement System shall be built and calibrated by a single manufacturer, ONICON Incorporated (or equivalent), and shall consist of a flow meter, two temperature sensors, a BTU meter, temperature thermowells, and all required mechanical installation hardware. A certificate of NIST* traceable calibration shall be provided with each system. All equipment shall be covered by the manufacturer’s two year warranty.

BTU METERS Provide an ONICON System-10 BTU Meter. The BTU meter shall provide the following points both at the integral LCD and as outputs to the building control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. Output signals shall be serial network protocol conforming to BACnet® MS/TP. Each BTU meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required). Panels mounted indoors shall be NEMA13, mounted outdoors shall be NEMA4,

Temperature sensors: Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched (NIST* traceable) for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within ±0.15°F (including the error from individual temperature sensors, sensor matching, input offsets, and calculations). Sensors applied on chilled water and mounted outdoors shall be equipped with thermal isolators to reduce condensation.
**Flow Meter:** Refer to meter schedule for specific flow meter type. The flow meter shall be installed either in the supply or return pipe of the system to be measured following the manufacturer’s instructions with particular attention paid to upstream and downstream straight pipe runs. Insertion type flow meters shall be provided with all installation hardware necessary to enable insertion and removal of the meter without system shutdown and shall be hand insertable up to 400 psi. For installations in non-metallic pipe, install grounding rings or probes as required. For flow meter installation details see the attached Flow Meter Installation Manual.

Provide an ONICON Model F1100 Turbine flow meter for 1.25” to 2” lines and F-1200 Dual Turbine Flow Meter for 2.5” and larger lines. Dual Turbine meters shall have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 0.5% of rate at the calibrated velocity, within ± 1% of rate over a 10:1 turndown (3.0 to 30 ft/s) and within ± 2% of rate over a 50:1 turndown (from 0.4 to 20 ft/s). Output signal shall be a 0-15 V square wave pulse. Bi-directional meters shall be FB-1200 Series and shall include an isolated contact closure output for direction.

* U.S. National Institute of Standards and Technology (or equivalent ISO standard)

**Flow Meter Installation Manual**

**A.3 GAS METERS**

Sierra 640S series or equivalent. SteelMass Industrial Insertion Mass Flow Meter. 18-30 VDC or 100-240VAC input power with 3/4-inch diameter 316SS probe. Provide "SmartElectronics" with PC configuration software. Meter shall have the following features:

- Direct mass flow monitoring
- Accuracy +/- 1% of reading plus 0.5%of full scale
- One-second response to changes in flow rate
Energy Management System (EMS) / Energy Information System (EIS)

“The building (or campus) should have a functioning EMS which is, at a minimum, capable of controlling, monitoring and trending building equipment. Ideally the EMS will have much greater granularity in its control capabilities and will also be capable of triggering alarms as systems drift from their designed operating conditions.

The campus must also utilize an EIS specifically designed for the tracking and evaluation of energy use meters and EMS points. The EIS should have the ultimate capability to log, store, and manipulate energy use information for every major building on campus for at least 10 years. 1

Recommended System or Equivalent

The selected system should be a web-based server software package that can perform all energy metering analysis and also be used as a Monitoring Based Commissioning (MBCx) tool. The basis of design is FacilityCare as provided by Syserco, or an equivalent product. At a minimum, the system will include the following components:

- Building Network Router – Each campus will require at least one network router to collect all meter data, provide local storage, and data uploads to the central web-based software tool.
- Web-based Software - FacilityCARE Analytics or equivalent. This is a web-based software tool for data collection, storage, and viewing of all data monitored by the system. All data can be viewed by anyone with logon access through their web-browser. This software shall be capable of the following functions: in-depth historical data analysis, data normalization by sq ft and weather, ability to compare buildings and campus energy use, and Monitoring Based Commissioning (MBCx). The software must reside on a server with an SQL database for data storage and database interoperability.
- Architecture – The kWh and BTU data is gathered by using either existing data available through the Building Management System or by providing new meters connected to the District WAN. This data is then gathered into the Web-based software for long term data storage and analysis.
- Data output – System will be able to output text or CSV files. Data will output the following data for each building and meter type. Data in rows for each customer record, with following names, tab delimited.
  - CAMPUS_ID – Campus name (VarChar)
  - CAMPUS_ADDRESS – Campus address (VarChar)
  - BUILDING_ID – Building Name (VarChar)
  - INTVL_LENGTH – Data interval length (Numeric)
  - DATA_TYPE – Type of data collected e.g. BTU, kW, kWh (VarChar)
  - DATE_TIME – Date and time stamp (Numeric)
  - USAGE – Energy usage amount (Numeric)

1 MBCx Minimum Project Guideline and Minimum Requirements