

San Francisco Airport Waterfront Marriott AHU-2 and AHU-2A Outline Operating Sequence

Overview

The AHU-2/AHU-2A system consists of two separate air handling units that together serve the lobby and lobby atrium area. AHU-2 is located in a mechanical space at the third floor level on the roof of the atrium and distributes air at the upper level of the atrium.

AHU-2A is located in a first floor mechanical room next to the pool area and distributes its air around the perimeter of the atrium at the first floor level. AHU-2A also provides ventilation air for the four meeting rooms located on the 2nd floor balcony area; Marina Del Rey, Monterey, Santa Barbara, and Santa Clara.

The scope of work associated with this project replaces AHU-2A unit with a new a modular air handling unit while retaining the existing AHU-2 unit. But, since the units interact with each other, the project will replace the controls on both systems to ensure that the operation of the units can be properly coordinated. Both systems are constant volume, single zone systems consisting of:

- An airside economizer section
- A MERV8 filter section
- A hot water heating coil intended for space heating purposes (no preheat or reheat)
- A chilled water cooling coil
- A supply fan
- Sound attenuators
- Supply and return distribution ducts

In addition to the components listed above, AHU-2 includes a relief fan that provides the relief path for both systems, including the relief damper, duct, and louver. AHU-2 also includes the atrium smoke exhaust fan which works in concert with both supply fans to provide a manually initiated smoke exhaust cycle.

Smoke exhaust fan EF-202 and general exhaust fan EF-201 also interact with AHU-2A at the meeting rooms. And a hot water baseboard heater is provided along the glass wall in the atrium, which is also in the zone served by the two air handling units. The system diagram included in Appendix 1 illustrates all of the components in the system.

This project does not significantly change the design intent for the two systems from what is shown on the original documents. However, the configuration of AHU-2A has been changed to incorporate deeper MERV13 flat filters along with provisions for carbon pre-filters to help mitigate jet exhaust odors from the airport.

The configuration also was modified facilitate access to the coils. Specifically, the heating coil for the unit has been moved from the preheat location to the reheat location in the ductwork downstream of the AHU itself. The original and current operating requirements for both systems are such that preheat will not be required¹, and the original operating sequences are such that the coils will only function to

¹ In other words, if the minimum outdoor air setting is at the design requirement and the economizer is working properly, the mixed air temperature will never drop below the design cooling coil leaving air temperature set point.

San Francisco Airport Waterfront Marriott AHU-2 and AHU-2A Outline Operating Sequence

provide heat to the space if the space is too cool with the with the unit on minimum outdoor air and using no chilled water.

Placing the coil in the reheat position provides the potential to implement a dehumidification cycle, which is desirable given that the unit supplies make up air to meeting rooms that are served by independent fan coil units capable of generating surface temperatures in the zones they serve that are potentially below the dew point of the air that would be delivered by AHU2 and AHU2-A under some outdoor conditions if the units are controlled only based on space temperature.

This potential can be seen in the psych chart included in Figure 1. Notice how maintaining a meeting room at the Marriott standard of 72°F/50% RH with a dew point of approximately 52.4°F requires that air be delivered at approximately 50.6°F or colder, depending on the sensible heat ratio (SHR) in the space.

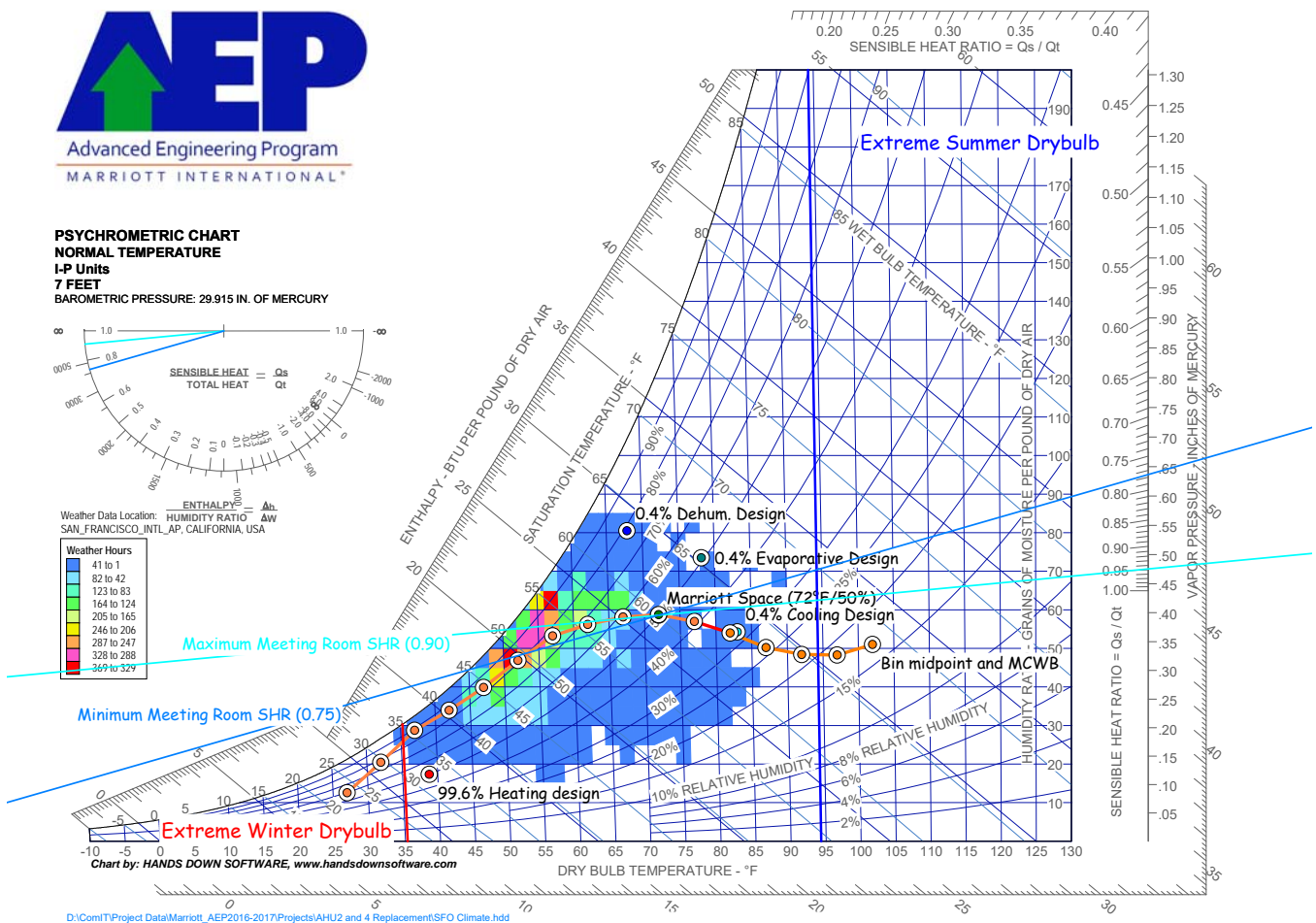


Figure 1 – San Francisco Climate and Design Metrics

But, since the discharge temperature from AHU-2A, which supplies make up air to the meeting room, is only controlled by space temperature, it would be possible for the system to be on 100% outdoor air via

San Francisco Airport Waterfront Marriott AHU-2 and AHU-2A Outline Operating Sequence

an economizer cooling process on a cool, foggy day which could introduce air with a dew point significantly above not only the Marriott space standard, but also the surface temperatures that would exist in the vicinity of the meeting room fan coil units and surfaces their discharge air stream impinged upon. As a result, condensation could occur on these surfaces, which could ruin finishes and create a number of other problems.

AHU 2A Start/Stop Control

AHU-2A shall run continuously due to the round-the clock nature of the lobby front desk operation. The existing smoke detector shall shut down and lock out the system if the detector is tripped. The fireman's over-ride panel shall be capable of bringing the supply fan back on even if the smoke detector has tripped as detailed in the Smoke Exhaust Cycle sequence.

AHU 2 Start/Stop Control

AHU-2 shall operate as required to supplement the cooling and heating provided for the lobby and atrium area by AHU-2A. Lobby space temperature shall be used to trigger the operation of the system as described below. Lobby space temperature shall be based on the average temperature reported by the three temperature sensors located in the lobby and atrium area as follows:

- One behind the front desk.
- One in the Bayside Room pre-function area.
- One on the North East or North West atrium column facing the atrium glass.

The software shall be arranged to allow the operators to select which sensors are included in the average space temperature calculation based on the graphic floor plan for the system.

The system shall be started any time the lobby temperature drops below the lobby space temperature set point of 72°F (adjustable) by more than 2°F (adjustable). The system shall also be started any time the lobby temperature rises above the lobby space temperature set point of 72°F (adjustable) by more than 2°F (adjustable).

Once the system is started, it shall remain on operation for the remainder of the day until 11:00 PM (adjustable), at which time, it shall be shut back down. The minimum off time shall be 1 hour (adjustable).

The existing smoke detector shall shut down and lock out the system if the detector is tripped. The fireman's over-ride panel shall be capable of bringing the supply fan back on even if the smoke detector has tripped as detailed in the Smoke Exhaust Cycle sequence.

EF-301 Start/Stop Control

Relief fan EF-301 shall run as required by the lobby static pressure control sequence as described in a subsequent paragraph. If AHU-2 and AHU-2A are both shut down, then EF-301 shall be shut down.

EF-202 Start/Stop Control

Meeting room general exhaust fan EF-201 shall run any time AHU-2 is in operation.

Fireman's Control Interface

The existing fireman's control panel shall provide the following functions

San Francisco Airport Waterfront Marriott AHU-2 and AHU-2A Outline Operating Sequence

1. A fireman's override of AHU-2 shall:

- Fully open the AHU-2 supply dampers and relief dampers and close the AHU2 return dampers.
- Start the AHU-2 supply fan
- Start relief fan EF-301
- Start smoke exhaust fan EF-302

2. A fireman's override of AHU-2A shall:

- Fully open the AHU-2A supply dampers and close the AHU2 return dampers.
- Start the AHU-2A supply fan
- Start meeting room general exhaust fan EF-301
- Start meeting room smoke exhaust fan EF-302

These functions should be existing functions. Under the scope this contract, verify these functions and report any issues to the Owner for resolution.

Atrium Baseboard Heat Control

A normally open valve serving the atrium baseboard heating element shall be modulated by a proportional only control loop as required to maintain the space temperature set point of 72°F (adjustable) based on the input received from the space temperature sensor on the North East or North West Atrium Column. As the temperature deviates below set point, the valve shall be modulated open and as the temperature deviates above set point, the valve shall be modulated closed.

The valve shall be forced close regardless of the space temperature any time the outdoor air temperature rises above 65°F (adjustable) for one hour or more (adjustable). Operation shall be allowed to resume when the outdoor air temperature drops below 65°F for one hour or more (adjustable).

Space Temperature Control

A proportional only control loop shall modulate the heating coils, economizer dampers, and cooling coils in AHU-2 and AHU-2A in sequence as required to maintain the desired space temperature set point based on the average space temperature as measured by the sensors at the following locations:

- One behind the front desk.
- One in the Bayside Room pre-function area.
- One on the North East or North West atrium column facing the atrium glass.

The software shall be arranged to allow the operators to select which sensors are included in the average space temperature calculation based on the graphic floor plan for the system.

If the space temperature rises from below set point to above set point, the following sequence shall occur.

1. With the space temperature at the bottom of the control process throttling range (the maximum deviation below set point), the system(s) shall be operating on minimum outdoor air with the chilled water valve fully closed and the heating valve fully open.

San Francisco Airport Waterfront Marriott AHU-2 and AHU-2A Outline Operating Sequence

3. As the space temperature begins to rise towards set point, the hot water valve shall modulate from fully open to fully closed while the system remains on minimum outdoor air.
4. If the space temperature continues to rise, then the economizer damper shall be allowed to modulate from minimum outdoor air/full return air towards 100% outdoor air/0% return air.
5. If the unit is on 100% outdoor air and the space temperature continues to rise, the chilled water valve shall be modulated from fully closed to fully open.
6. If the space temperature begins to drop, the sequence shall be reversed.

Both units shall be controlled by the same control process when they are in operation. If a unit shuts down for any reason, its outdoor air damper, relief air damper (if so equipped), chilled water valve, and hot water valve shall be forced fully closed.

An independent mixed air low limit control process (one per system) shall over-ride the economizer dampers as described below to limit the mixed air temperature to the systems design leaving air temperature set point, regardless of the command from the space temperature control process. This is described in a subsequent paragraph.

The economizer processes are intended to be integrated economizer processes. The economizer cycle will be returned to the minimum outdoor air position when the outdoor air temperature exceeds 72°F (adjustable) for 15 minutes or more (adjustable). The economizer cycle will be allowed to resume operation when the outdoor air temperature drops back down below 72°F.

A reheat cycle, as described below, overrides this space temperature-based control process to minimize the potential for condensation in the meeting rooms served by AHU-2A.

AHU-2A Reheat Cycle

This cycle only applies to AHU-2A.

The control system shall monitor the fan coil unit leaving air temperatures in the Marina Del Rey, Monterey, Santa Barbara, and Santa Clara meeting rooms and shall retain the minimum temperature seen in each room over the past hour (adjustable).

To minimize the potential for condensation in the meeting rooms it serves, AHU-2A shall initiate a reheat cycle any time the outdoor dew point temperature rises above the lowest leaving air temperature seen in any of the meeting rooms in the past hour (*adjustable*). When this happens, the chilled water valve in AHU-2A shall be modulated by a proportional plus integral control loop to *maintain a set point equal to the coldest observed meeting room leaving air temperature*. As the cooling coil leaving air temperature deviates below set point, the valve shall be modulated closed. As the cooling coil leaving air temperature deviates above set point, the valve shall be modulated open.

The economizer dampers and heating coil valve shall continue to be modulated based on the space temperature during this cycle. When the outdoor air dew point temperature drops back down below the lowest meeting room fan coil unit leaving air temperature, the reheat cycle shall be terminated and the AHU-2A chilled water valve shall return to being modulated by the AHU-2A space temperature control sequence as described above.

San Francisco Airport Waterfront Marriott AHU-2 and AHU-2A Outline Operating Sequence

Mixed Air Low Limit Control

This sequence applies to AHU-2 and AHU-2A.

The averaged output from all of the flexible averaging mixed air sensors serving the system² provide an input to a proportional only mixed air low limit control process. The output of the control process shall over-ride the signal to the economizer dampers from the space temperature control process to limit the mixed air temperature to the design cooling coil discharge temperature for the system (54.4°F for AHU-2 and 53.9°F for AHU-2A, both adjustable).

As the mixed air temperature drops below the low limit set point, the mixed air dampers will be modulated towards the 100% return air/minimum outdoor air position, even if the space temperature control cycle is trying to drive them the other way. When the mixed air temperature rises above the mixed air low limit set point, control of the economizer dampers shall revert back to the space temperature control process.

Minimum Outdoor Air Flow Control

Both AHU-2 and AHU-2A are intended to operation with a fixed percentage of outdoor air.

- AHU-2 minimum outdoor air flow = 1,590 cfm (9%)
- AHU-2 minimum outdoor air flow = 1,290 cfm (12.5%)

The Temperature Control Contractor shall coordinate with the Testing, Adjusting and Balancing contractor to determine the appropriate minimum position signal for each system's outdoor air damper required to provide the intended minimum outdoor air flow rate. When the units are in operation, the outdoor air damper position shall not be allowed to modulate below this value, regardless of what the output of the space temperature control sequence is requesting.

The required minimum position and the associated flow rate shall be documented in the as-built documentation and as a hard number in the system graphics. A separate variable shall allow the operators to select a different outdoor air minimum position from the one identified during the TAB process. But if the position they select is not the position identified during TAB, the value they enter in the graphic shall made red and a warning message shall show up on the graphic indicating that they have set the minimum outdoor air setting to something other than the value identified during TAB.

Lobby Static Pressure Control Sequence

The relief fan located in the equipment room associated with AHU-2 provides for the relief of air brought in by both AHU-2A as well as AHU-2, thus, it needs to be allowed to operate when either of the units are in operation and the lobby static pressure exceeds set point as described below.

A space static pressure sensor measuring lobby static pressure relative to the ambient pressure at the main entrance provides an input to a proportional plus integral control process. The output of the

² Per the point list, there shall be enough mixed air sensors installed to ensure that there is 1 foot of flexible averaging element provided for every 4 square foot of mixed air plenum cross-sectional area. If more than one sensor is required to achieve this, then the temperatures shall be averaged in software and reported as the average mixed air temperature in addition to reporting the information from each sensor in the array.

San Francisco Airport Waterfront Marriott AHU-2 and AHU-2A Outline Operating Sequence

control process modulates the relief dampers on the discharge of fan EF-301 in sequence with the fan speed as necessary to maintain the lobby at a positive pressure of 0.10 in.w.c. (adjustable).

As the lobby pressure begins to deviate above set point, the relief dampers modulate from closed towards open. When the dampers are fully open, EF-301 shall be started on minimum speed. If the lobby pressure continues to deviate above set point, the speed of EF-301 shall be increased as required to maintain set point. A deviation in lobby pressure below set point shall reverse the sequence.

Diagnostics

Provide the following diagnostic alarms:

1. Provide operating and warning alarms as described in the point list.
2. Alarm if a piece of equipment is running when it should not be or vice versa.
3. Alarm if the system is using hot water to heat when the chilled water coil or economizer processes are active unless it is a time when AC-2A is in a reheat cycle.
4. Alarm if the system is using chilled water and the economizer dampers are not at 100% outdoor air unless the outdoor air temperature is above the economizer high limit set point.

Alarms should be triggered with-in 60 seconds (adjustable for each alarm) from the point in time when the alarm condition was detected unless otherwise indicated.

San Francisco Airport Waterfront Marriott AHU-2 and AHU-2A Outline Operating Sequence

C:\Users\Dsellars\AppData\Local\Microsoft\Windows\Inetcache\Content.Outlook\L8N01162\Outline Sequence Of Operation V1.Docx

Appendix 1

AHU-2 and AHU-2A System Diagram