



HVAC Assessment Final Report

10/22/2021

FINAL ISSUE



Scenic Regional Library HVAC Assessment

Pacific | Sullivan | Wright City

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FINAL HVAC ASSESSMENT REPORT

1. GENERAL PROJECT INFORMATION

Project: HVAC Assessment
 Location: Pacific, Sullivan & Wright City, Missouri
 Building Type: Library
 Owner: Scenic Regional Library

2. EXECUTIVE SUMMARY

The project consisted of an assessment of the HVAC systems serving three library facilities. The assessment was requested due to humidity complaints throughout the facilities and in some cases damage to books. The assessment incorporated a review of the installed versus design systems and performance and space metrics measured using standalone data loggers.

The table below shows that the units serving the library spaces are maintaining average space conditions within acceptable ranges. The base recommendations are provided, for these units strictly to improve performance and provide consistency for the systems. For the units serving non-library spaces there is some sub-cooling present however space conditions are acceptable except for Wright City. These units are oversized, and the recommendations provided will improve overall thermal comfort as well as extending the life of the equipment.

The following observations are a consistent challenge for all buildings encompassed in this report:

- Currently no dehumidification control/capability at the HVAC units.
 - Recommended space conditions for a library/archival space are 70°F (Dry Bulb) | 50% (Relative Humidity) | 50.5°F (Dew Point).
- Lack of re-heat on HVAC units serving the library spaces.
- Engineering rule of thumb uses 0.75 CFM/ft² – 1.25 CFM/ft² as an expected range to airflow sizing. AHU-2 in both Pacific and Sullivan are greater than 1.25 CFM/ft². Wright City is 1.24 but unit is only equipped with 1 stage of cooling resulting in the unit short cycling and unable to maintain space humidity levels. To truly determine correct sizing a review of the Mechanical Engineers load calculation is required.
- Appears from data analysis on 9/19 thermostat settings were changed at Wright City to a zone setpoint of 74°F. This resulted in a spike in Humidity levels in the space. Lockable thermostats should be used to prevent this in the future.

The following table provides a concise overview of the HVAC systems that were part of the assessment effort (**Note AHU-1 in the facilities serves the Library area while AHU-2 serves the Meeting rooms.**)

Location	Unit ID	Conditioned Area ft ²	Supply Air CFM	CFM/ft ²	Cooling Capacity Design Tons	Cooling Capacity Design MBH	Cooling Capacity Actual MBH	Cooling Capacity % of Design	Average Space Temperature	Average Space Humidity	Average Space Dewpoint	Target Space Dewpoint	Max Space Humidity
Pacific, MO	AHU-1	6,800	7,000	1.03	17.5	208	164	78.8%	70.4F	38.9F%	44.2F	50.5	49.7%
Pacific, MO	AHU-2	1,434	3,400	2.37	8.5	104	134	128.8%	71.3F	43.9%	48.2F	52.4	50.4%
Sullivan, MO	AHU-1	7,052	8,000	1.13	20	259	270	104.2%	70.9F	51.4%	51.1 F	50.5	59.3%
Sullivan, MO	AHU-2	1,465	2,500	1.71	6.5	81	100	123.5%	67.8	54.1%	50.6F	52.4	59.0%
Wright City, MO	AHU-1	4,924	4,500	0.91	15	174	141	81.0%	70.9F	49.0%	50.8F	50.5	62.0%
Wright City, MO	AHU-2	1,132	1,400	1.24	4	47.5	51	107.4%	70.63 F	62.0%	56.4F	52.4	71.0%

2.1 DATA COLLECTION STRATEGY

The data provided in the appendices is data that has been analyzed for purposes of this report. Temperature & humidity data loggers for each HVAC system were placed in the following locations:

- Near the control thermostat
- Before the cooling coil in the unit
- In the supply air duct

2.2 BASE RECOMMENDATIONS – ALL UNITS

The following recommendations are provided for all units associated with this assessment.

- Dehumidification capability/control should be introduced at each unit. To accomplish this, it is recommended that Adiabatic Proportional Refrigerant (APR) Control is added to each HVAC unit. This is a relatively simple process and will facilitate dehumidifying of the air using the existing equipment. Reference the appendix for additional information.
 - Note the recommended APR control is also designed to mitigate issues with oversized HVAC equipment which causes short cycling.
- Existing thermostats are cycling cooling excessively and do not provide for dehumidification control. The cycling is due to the limited control dead band and equipment oversizing. New control thermostats are recommended that monitor not only temperature but humidity and control to maintain both. Reference the appendix for additional information.
- OA dampers appeared to be almost completely closed. This was most likely done as a previous attempt to control humidity levels. Recommend setting OA dampers to previous TAB setpoints for ventilation requirements.

2.3 BASE RECOMMENDATIONS – ESTIMATED COSTS

The following recommendations are provided for all units associated with this assessment.

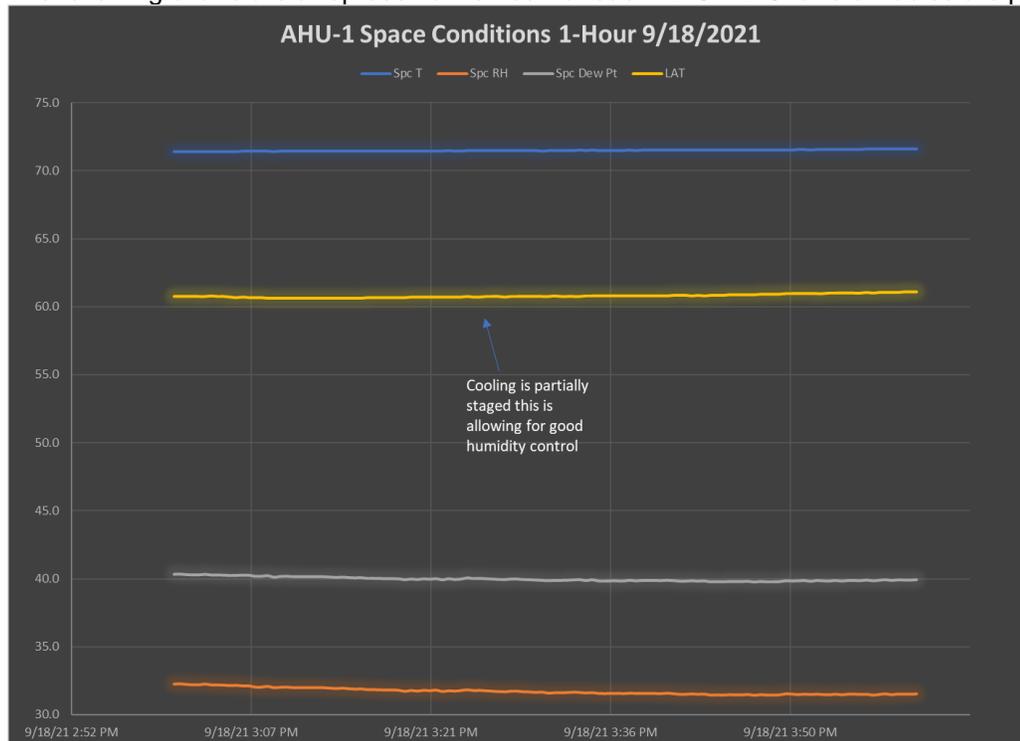
- Dehumidification capability/control inclusion:
 - Estimated material cost per unit is \$900. Estimated install per unit is \$600.
- New Control Thermostats:
 - Estimated cost per sensor is \$200. Estimated install per sensor including configuration is \$300.
 - Place setpoints for Library HVAC to control at 70°F & 50%RH (**Note these changes should be made at the existing thermostats**).
 - Place setpoints for Meeting Room HVAC to control at 72°F & 50%RH (**Note these changes should be made at the existing thermostats**).
- Total Estimated Costs for **Pacific** are **\$4,000 (Note this includes a 10% contingency)**:
 - Rawal APR Devices including install - \$3,000
 - Viconics VT7657B5000 RTU Thermostat with Humidity Control including install - \$1,000
- Total Estimated Costs for **Sullivan** are **\$4,000 (Note this includes a 10% contingency)**:
 - Rawal APR Devices including install - \$3,000
 - Viconics VT7657B5000 RTU Thermostat with Humidity Control including install - \$1,000
- Total Estimated Costs for **Wright City** are **\$4,000 (Note this includes a 10% contingency)**:
 - Rawal APR Devices including install - \$3,000
 - Viconics VT7657B5000 RTU Thermostat with Humidity Control including install - \$1,000

3. OBSERVATIONS – PACIFIC

The following observations were noted when analyzing the data logger information for the Sullivan site. Note this site is performing much better with respect to maintaining temperature & humidity requirements in both the library and the meeting space.

Designation	Notes
AH-1	<p>Full Cooling cycles on/off every 20-30 minutes in the mornings with Lower stages of cooling enabled most of the afternoons. This is helping keep Humidity levels down in the space. Deadband appears to be 1F. Space humidity ranged between 29% - 49%. Unit has 4-stages of cooling.</p> <p>Cooling for this unit needs to be checked. The unit is operating at 79% of Total Capacity. However analysis of the data does show that the unit is maintaining space conditions well.</p>
AH-2	<p>Cooling cycles on/off every 20-25 minutes. There appears to be a 1F deadband. Space humidity ranged between 43% - 51%. Has 2-stages of cooling.</p> <p>This unit is greatly overperforming and is maintaining library conditions as intended.</p> <p>Sized for approximately 2.3 cfm/sqft. Unit is over 2 times the size of what is typically required.</p>

The following charts are a representative hour for each AHU. All Charts & Tables are provided in the appendices.



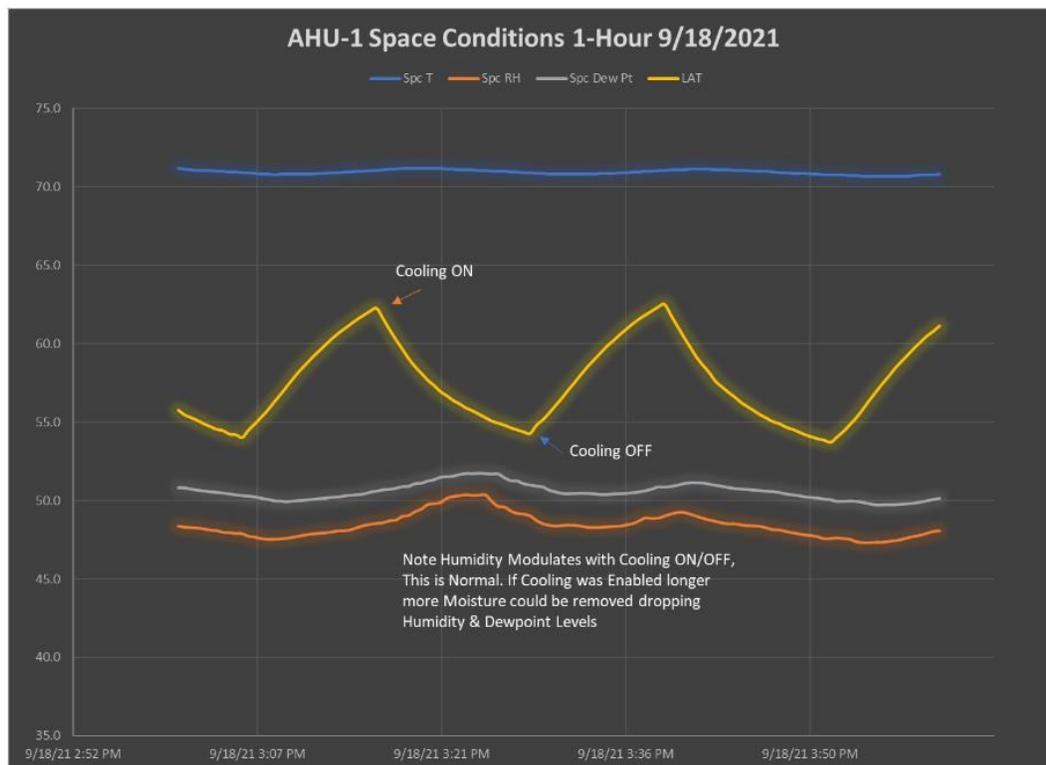


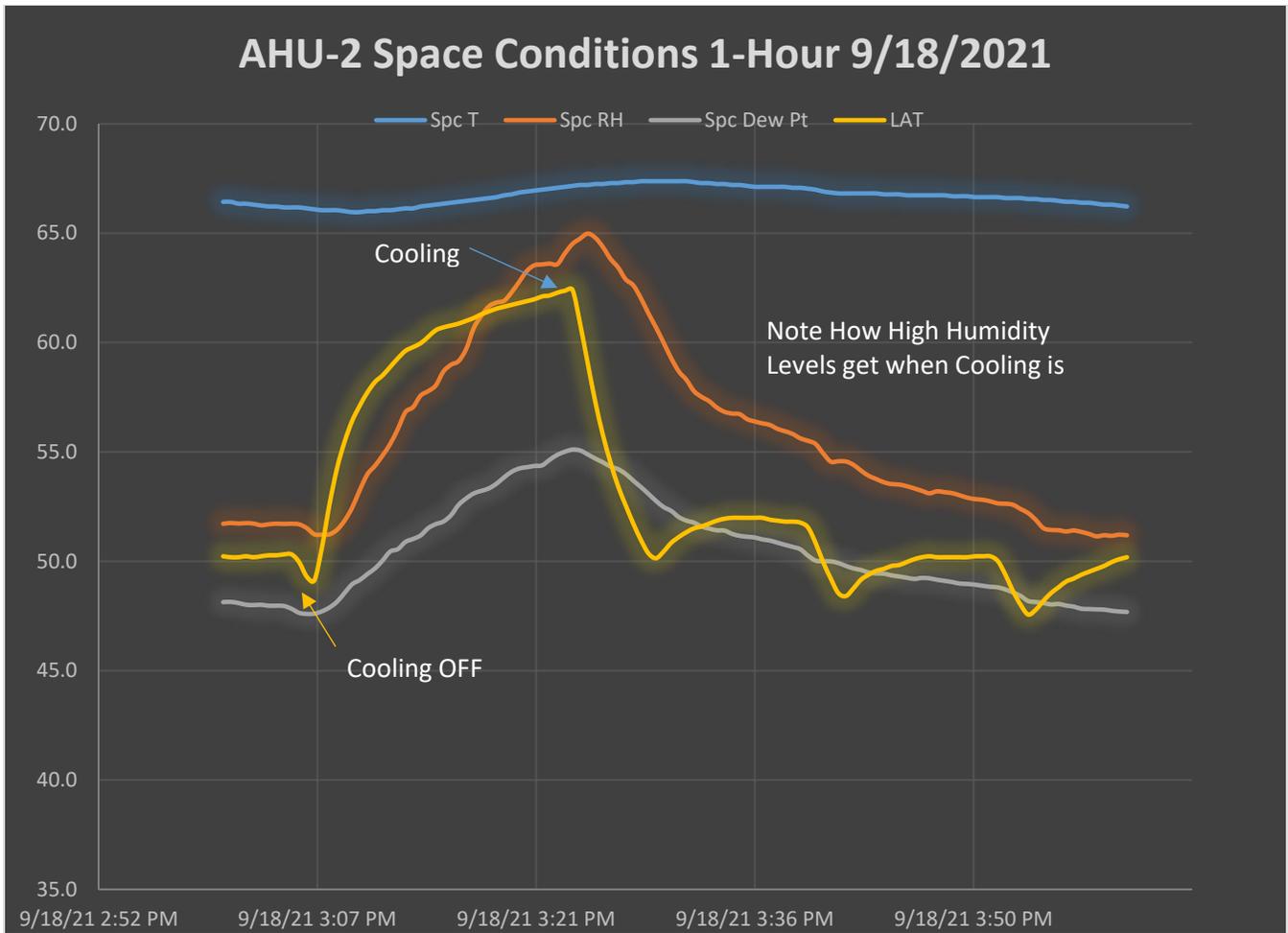
4. OBSERVATIONS – SULLIVAN

The following observations were noted when analyzing the data logger information for the Sullivan site.

Designation	Notes
AH-1	<p>Cooling cycles on/off every 12-20 minutes. Data shows a 1F deadband. Space humidity reached 59% with the average humidity level at 51.4%. Humidity levels reached its max at night when space temperature was satisfied so there was no cooling demand.</p> <p>This unit is performing to maintain library space temperature conditions as intended.</p>
AH-2	<p>Cooling cycles on/off every 5-10 minutes. There appears to be a 1F deadband. Space humidity averaged 54% with the high space humidity being recorded at 59%. Unit Has 2-stages of cooling.</p> <p>Since this unit is cycling ON/OFF so quickly there is poor humidity control in this area.</p> <p>Sized for approximately 1.7 cfm/sqft. Unit is over 1.5 times the size of what is typically required.</p>

The following charts are a representative hour for each AHU. All Charts & Tables are provided in the appendices.



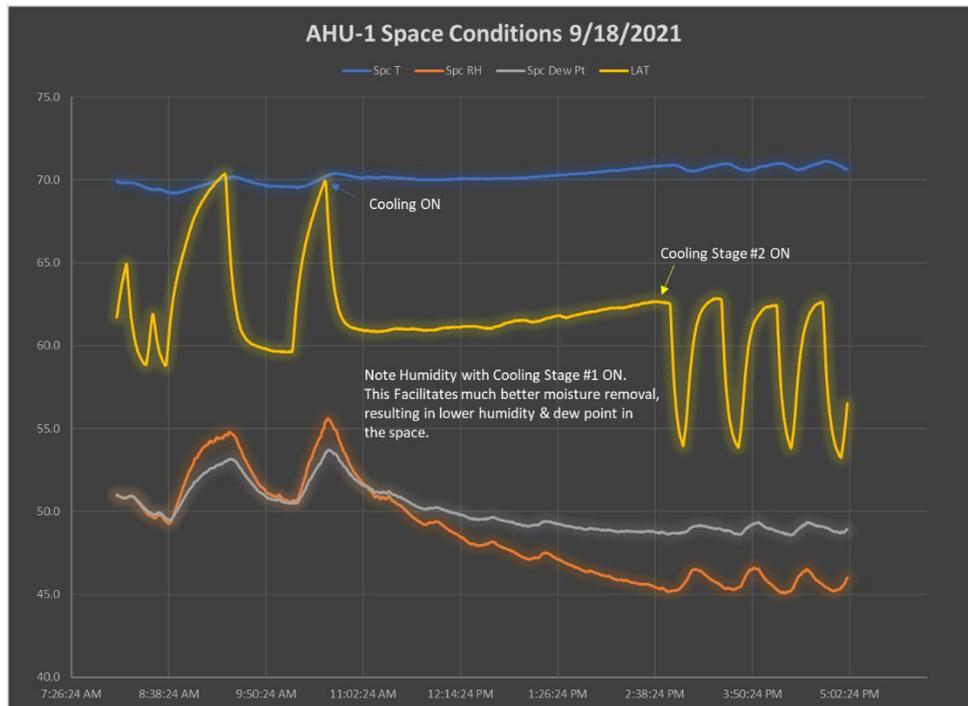


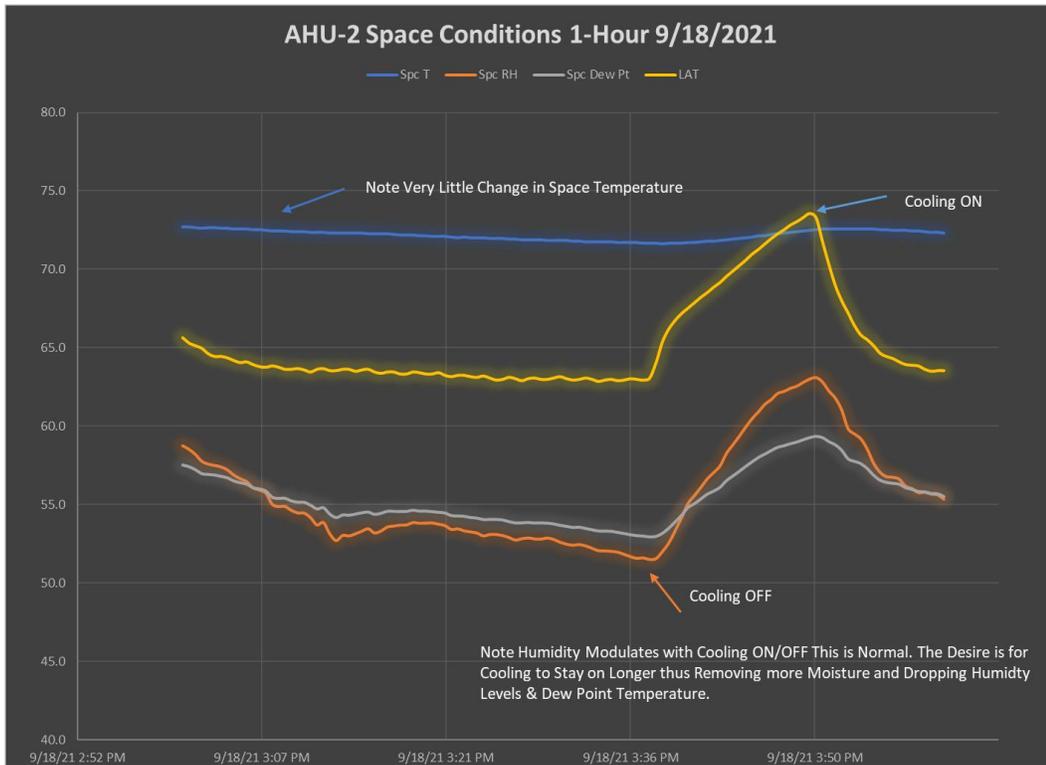
5. OBSERVATIONS – WRIGHT CITY

The following observations were noted when analyzing the data logger information for the Wright City site. Note this site is performing the worst with respect to maintaining temperature & humidity requirements in both the library and the meeting space.

Designation	Notes
AH-1	<p>Cooling cycles on/off every 15-20 minutes. Data shows a 1F deadband. Space humidity reached 62% with an average space humidity of 49%. Appears from data analysis thermostat settings were adjusted on 9-19 to 74°F. This caused the zone humidity levels to spike with no cooling required to meet zone setpoints. Unit has 2-stages of cooling.</p> <p>Cooling for this unit needs to be checked. The unit is operating at 81% of Total Capacity. However analysis of the data does show that the unit is maintaining space conditions well.</p>
AH-2	<p>Cooling cycles on/off every 6-10 minutes. There appears to be a 1F deadband. Space humidity reached 71% with an average space humidity of 62%. Unit has 1-stages of cooling.</p> <p>With only one stage of cooling and the short ON/OFF times this space has the highest max humidity levels at 71%.</p>

The following charts are a representative hour for each AHU. All Charts & Tables are provided in the appendices.





APPENDIX A - RAWAL DEVICES APR CONTROL DATA SHEET



The APR Control®

Transform any standard DX Air Conditioning system into a variable capacity system!

The APR Control provides continuous capacity modulation for any standard DX system, solving many of the issues that come with commonly oversized systems. The APR is a ***completely mechanical*** device that responds to suction pressure, thus able to properly match the system capacity to the ever-changing load and space requirements. Our valve has had proven success for improved system performance in both new and existing equipment.

Why you would use it?

Performance: Eliminates short cycling by increasing the compressor runtimes for better latent cooling performance, resulting in greater indoor comfort and improved indoor air quality.

Value: It is a cost-effective add-on device providing better temperature and humidity control while offering low pressure compressor protection.

Simplicity: Ease of installation, troubleshooting and commissioning.

Compliant: Meets ASHRAE 90.1 standard of continuous capacity modulation.

The APR Control has yielded success amongst a wide variety of applications such as:

- Schools (*Early education to college facilities*)
- Process Manufacturing Facilities
- Hospitals (*Surgical Suites*)
- Labs (*Cleanrooms*)
- Retail Spaces (*Shopping Malls to Restaurants*)
- Office Spaces (*Utilizing single or multi zone VAV systems*)
- Data Centers



The APR allows you to achieve optimal system performance while providing modulation for all sizes and configurations of air conditioning systems – yielding long term benefits. By matching system capacity to continuously changing load conditions, an APR Control® - enhanced system is able to maintain better comfort, as well as provide a number of unique solutions that standard DX air conditioning systems are unable to achieve.

Have an application you wish to discuss or simply want to learn more? Speak with our Technical Sales Support Team today!

Call: (800) 727-6447

Email: Sales@rawal.com

Visit: www.Rawal.com

APPENDIX B - VICONICS VT76 INFORMATION

VT76x7B5000 Series Roof Top Unit Thermostats with Humidity Control



The VT76x7 PI thermostat family is specifically designed for single stage and multi-stage control of heating/cooling equipment such as rooftop and self-contained units with humidifier and/or dehumidifier. The product features an embedded complete humidity solution with an intuitive, menu-driven, backlit LCD display that walks users through the programming steps, making the process extremely simple. All models contain one digital input, which can be set by the user to monitor filter status, change the occupancy status, and/or used as a general purpose service indicator. The two models contain SPST auxiliary switch, which can be used to control lighting and a discharge air sensor input.

Available Models

MODEL	HUMIDITY FUNCTION	2HEAT/2COOL	INTERNAL SCHEDULING
VT7607B5000	•	•	
VT7657B5000	•	•	•

Add B for BACnet models, E for Echelon models or W for ZigBee wireless models. Ex: VT76x5B5000B, VT76x5B5000E, VT76x5B5000W.
Replace 5000 by 5500 for factory installed PIR cover

Parameter name	Function	Range/Options
Pswrd	Configuration parameters menu access password	Range is: 0 to 1000
%RH disp	Enables %RH to be displayed below room temperature	ON or OFF
DI1	Defines the use of binary input DI1	None, Rem NSB, RemOVR, Filter, Service, Fan lock
Lockout	Sets the keypad lockout level	0, 1, 2
Pwr del	Sets the power-up delay of the thermostat	10 to 120 seconds
Frost pr	Enables frost protection	ON or OFF
Heat max	Sets the maximum heating setpoint limit	40 to 90 °F (4.5 to 32.0 °C)
Cool min	Sets the minimum cooling setpoint limit	54 to 100 °F (12.0 to 37.5 °C)
Anticycle	Sets minimum On/Off operation time for stages	0, 1, 2, 3, 4, 5
Heat cph	Sets the maximum number of cycles for heating stages per hour	3, 4, 5, 6, 7, 8
Cool cph	Sets the maximum number of cycles for cooling stages per hour	3, 4, 5, 6, 7, 8
Deadband	Sets the minimum deadband between cooling & heating setpoints	2, 3, or 4 °F (1.0 to 2.0 °C)
Fan cont	Sets the fan control mode	ON or OFF
Fan del	Extends fan operation by 60 seconds after demand ends	ON or OFF
Com Addr*	Sets the Com address of the thermostat	0 to 254
PAN ID**	Sets the PAN ID of the thermostat	0 to 500
Channel**	Sets the channel of the thermostat	10 to 26
Get From**	Chooses thermostat to import configuration from	0 to 254
TOccTime	Sets the temporary occupancy time when overriding.	0 to 12 hours (in 1 hour increments)
Cal RS	Room air temperature sensor calibration	± 5.0 °F
Cal OS	Outside air temperature sensor calibration	± 5.0 °F
H stage	Sets the number of heating stages used	1 or 2
C stage	Sets the number of cooling stages used	1 or 2
H lock	Sets the outside air temperature heating lockout	-15 to 120 °F (-26 to 49 °C)
C lock	Sets the outside air temperature mechanical cooling lockout	-40 to 95 °F (-40 to 35 °C)
Unocc TM	Sets the unoccupied Timer value	0.0 to 24 hours (in 0.5hr increments)
2/4event	Sets the number of events for the occupancy schedule	2 or 4
aux cont	Sets the auxiliary contact to N.O. or N.C	N.O. or N.C
Prog rec	Enables the progressive recovery function	ON or OFF
RH LT	Minimum outside temperature for RH setpoint reset	-40 to 15 °F (-40 to 9.5 °C)
RH HT	Maximum outside temperature for RH setpoint reset	-20 to 55 °F (-6.5 to 13 °C)
HL Sp	High limit supply humidity setpoint	50 to 90%
Dhu OALK	Outside air temperature under which dehumidification is disabled	-40 to 122 °F (-40 to 50 °C)
Dhu LCK	Enables or disables the lockout functions for the duhum. output	ON or OFF
DehuHyst	Sets the value for the dehumidification hysteresis	2 to 20%
RE Sp	Value at which the RH setpoint will be reset based on RH LT	10 to 90%
RH cal	Relative humidity sensor calibration	± 15%
Display HL	Displays the high limit sensor value	Displays the high limit sensor value

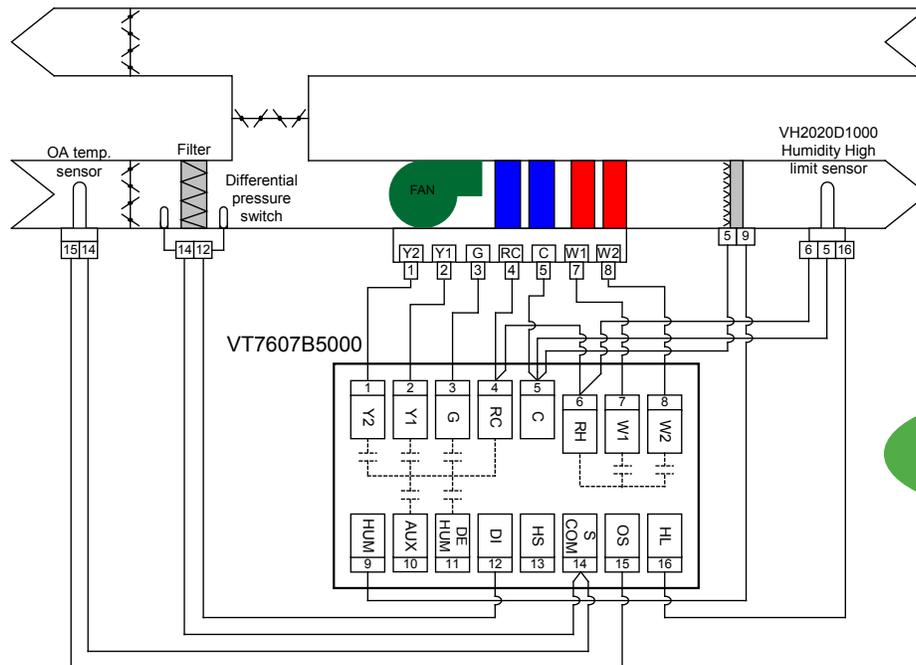
* Only available in Wireless (VT7605B5000W) and BACnet (VT7605B5000B) models (**) Only available in Wireless (VT7605B5000W) models

Features

- **Embedded humidification sequence (0-10 Vdc output) and dehumidification sequence (dry contact)**
Simplifies installation and reduce installation costs
- **Internal RH sensor embedded**
Eliminates components
- **Proportional high limit override**
Prevents costly damage due to over-humidification
- **Humidity set point reset based on outdoor temperature**
Saves energy and prevents window condensation in colder climates
- **Sensor failure protection**
Prevents water damage
- **PI time proportioning algorithm**
Increased comfort , accuracy, and energy savings
- **1 digital input**
Adds functionality
- **Smart fan**
Saves energy during night mode
- **Unique local configuration utility**
Minimizes parameter tampering
- **Lockable keypad**
Tamper proof, no need for thermostat guards
- **Freeze protection**
Prevents costly freeze damage
- **EEPROM memory**
No loss of program
- **6 hour reserve time for clock**
No need to reprogram day/time after power shortage
- **Remote room and outdoor temperature sensor**
Increase flexibility and functionality
- **Auxiliary output**
Can be used for lighting and/or economizer override
- **Discharge air sensor**
Can be used to monitor unit efficiency
- **Intuitive, menu-driven programming (on programmable models)**
Can be used for all types of establishments

Typical 2H/2C Application With Humidity Control:

- Single Speed Fan
- Humidifier
- Supply Air Temperature Sensor
- Outside Air Temperature Sensor
- Differential Pressure Switch



See Page VT4 for Dimensions and specifications

Model no.	Accessory
S3010W1000	Wall mounted temperature sensor
S3020W1000	Wall mounted temperature sensor with override key and occupancy status LED
S2060A1000	Averaging temperature sensor
S2020E1000	Outside air temperature sensor with enclosure

See page S3-S4-S5 in Sensors section for details

Model no.	Accessory
S2000D1000	Duct mounted temperature sensor
S1010D1000	Low cost duct mounted changeover temperature sensor
S1010E1000	Capsule type general purpose temperature sensor
COV-BC	Thermostat blind cover
VH20 series	Humidity transmitters (See pages H9-H10)

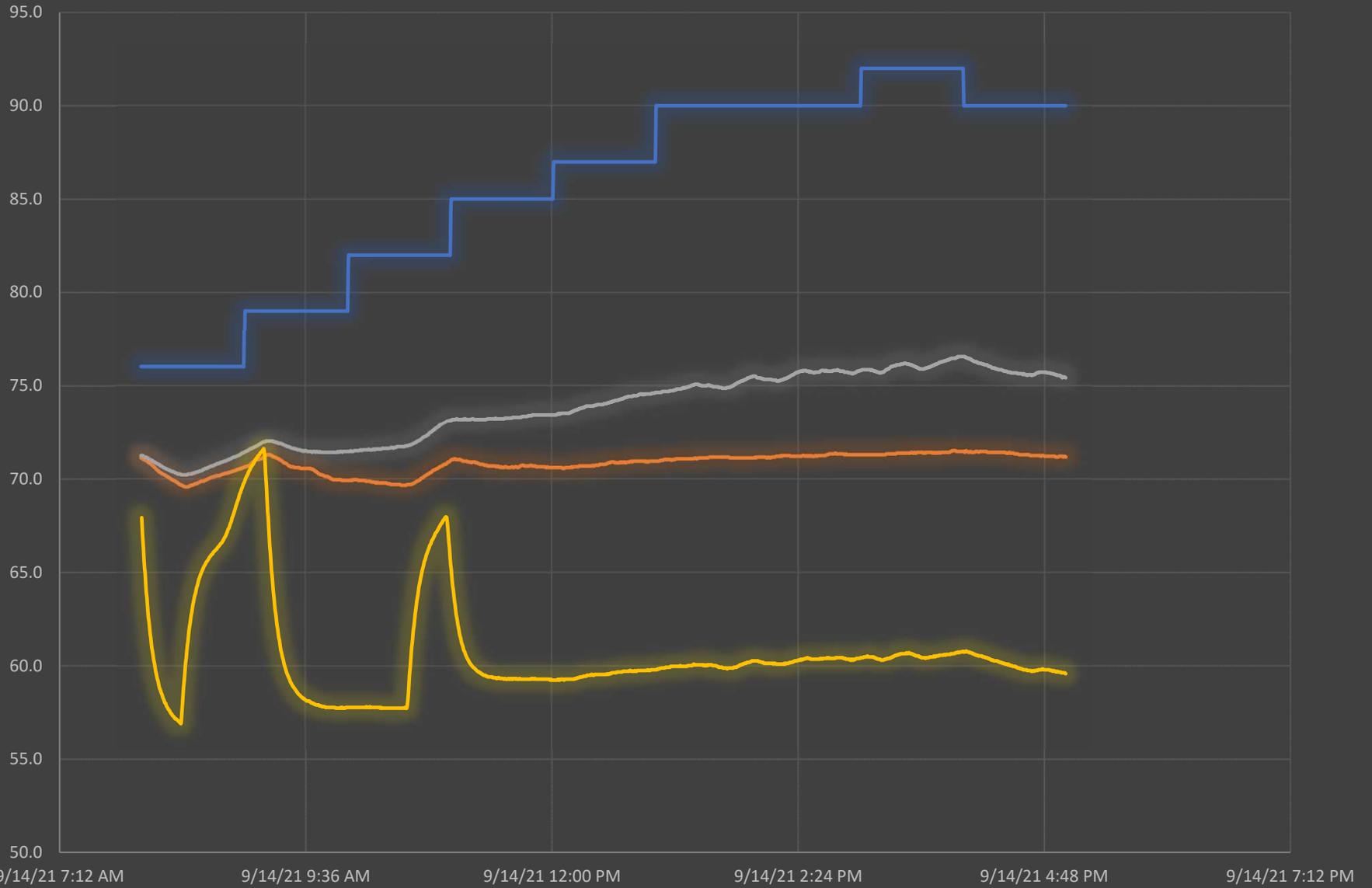
APPENDIX C - PACIFIC DATA TABLES & CHARTS

AHU-1 Data Tables

Date Time	OAT	OAH	OA-Enth	OA Dew Pt	RAT	RAH	Spc T	Spc RH	Spc Dew Pt	EAT	EAH	EA-Enth	LAT	LAH	LA-Enth	LA Dew Pt	Coil ΔT	Coil Δh	Spc vs LA Dew Pt
9/14/21 4:55 PM	90.0	46.0	36.9	66.5	72.0	37.2	71.2	33.7	41.2	75.6	33.6	25.0	59.7	47.3	19.9	45.0	15.9	5.1	-3.8
9/14/21 4:56 PM	90.0	46.0	36.9	66.5	72.0	37.2	71.2	33.7	41.2	75.6	33.7	25.0	59.7	47.3	19.9	45.1	15.9	5.2	-3.9
9/14/21 4:56 PM	90.0	46.0	36.9	66.5	72.0	37.1	71.2	33.7	41.2	75.6	33.6	25.0	59.7	47.3	19.9	45.0	15.9	5.2	-3.8
9/14/21 4:57 PM	90.0	46.0	36.9	66.5	71.9	37.1	71.2	33.7	41.3	75.6	33.7	25.0	59.7	47.3	19.9	45.0	15.9	5.2	-3.8
9/14/21 4:57 PM	90.0	46.0	36.9	66.5	71.9	37.1	71.2	33.6	41.2	75.5	33.6	25.0	59.7	47.3	19.9	45.0	15.9	5.1	-3.8
9/14/21 4:58 PM	90.0	46.0	36.9	66.5	71.9	37.2	71.2	33.6	41.2	75.5	33.6	25.0	59.6	47.3	19.9	45.0	15.9	5.1	-3.8
9/14/21 4:58 PM	90.0	46.0	36.9	66.5	71.9	37.2	71.2	33.6	41.2	75.4	33.8	25.0	59.6	47.3	19.9	45.0	15.8	5.1	-3.9
9/14/21 4:59 PM	90.0	46.0	36.9	66.5	72.0	37.3	71.2	33.6	41.2	75.5	34.0	25.1	59.6	47.5	19.9	45.2	15.9	5.2	-4.0
9/14/21 4:59 PM	90.0	46.0	36.9	66.5	72.0	37.3	71.2	33.6	41.2	75.5	34.1	25.1	59.6	47.5	19.9	45.3	15.9	5.2	-4.1
9/14/21 5:00 PM	90.0	46.0	36.9	66.5	72.0	37.3	71.2	33.6	41.2	75.5	34.1	25.1	59.6	47.6	19.9	45.3	15.9	5.2	-4.1
9/14/21 5:00 PM	90.0	46.0	36.9	66.5	72.0	37.3	71.2	33.7	41.2	75.4	34.2	25.1	59.6	47.7	19.9	45.4	15.9	5.2	-4.2

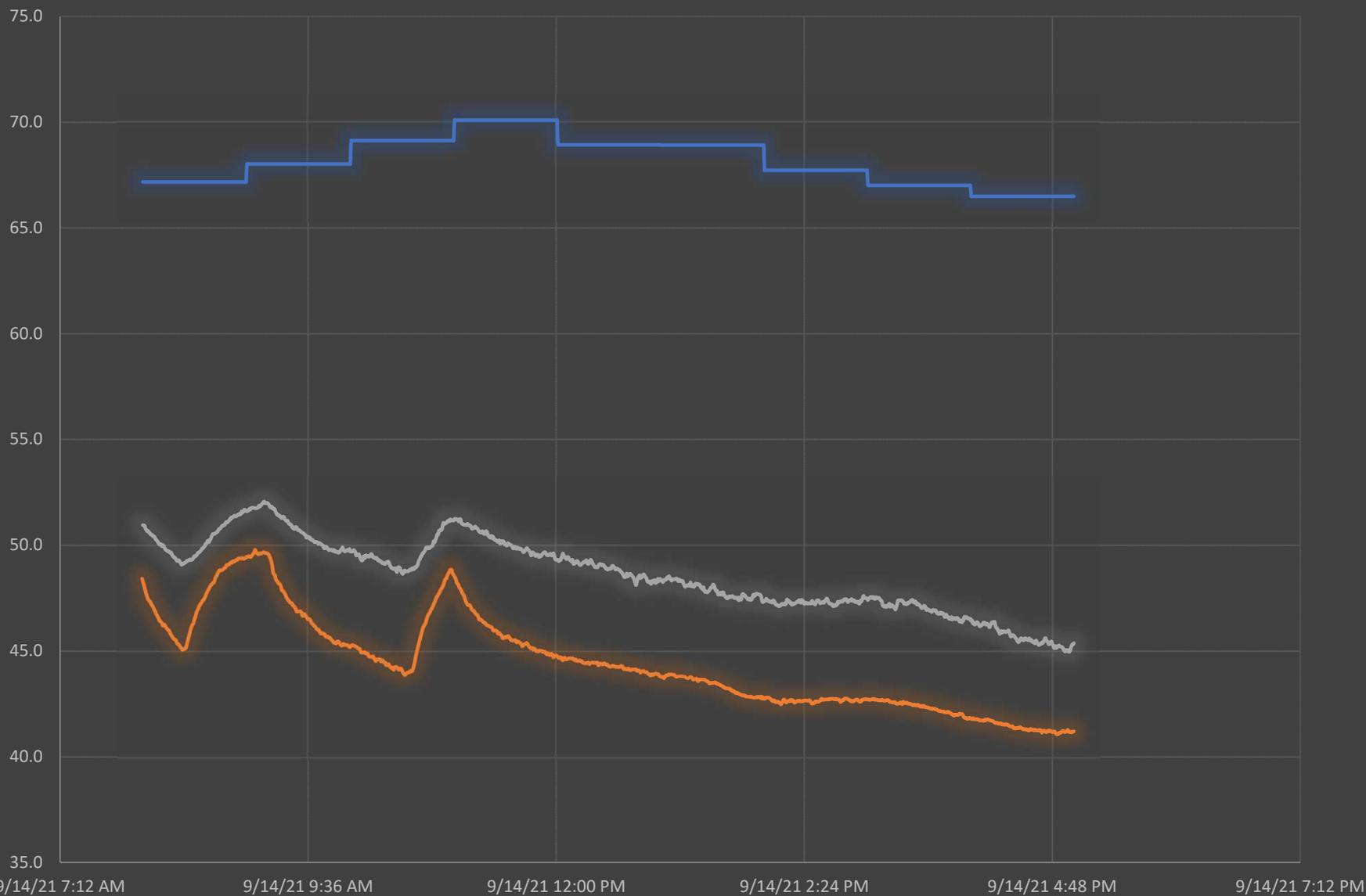
AHU-1 Space Conditions 1-Hour 9/14/2021

OAT Spc T EAT LAT



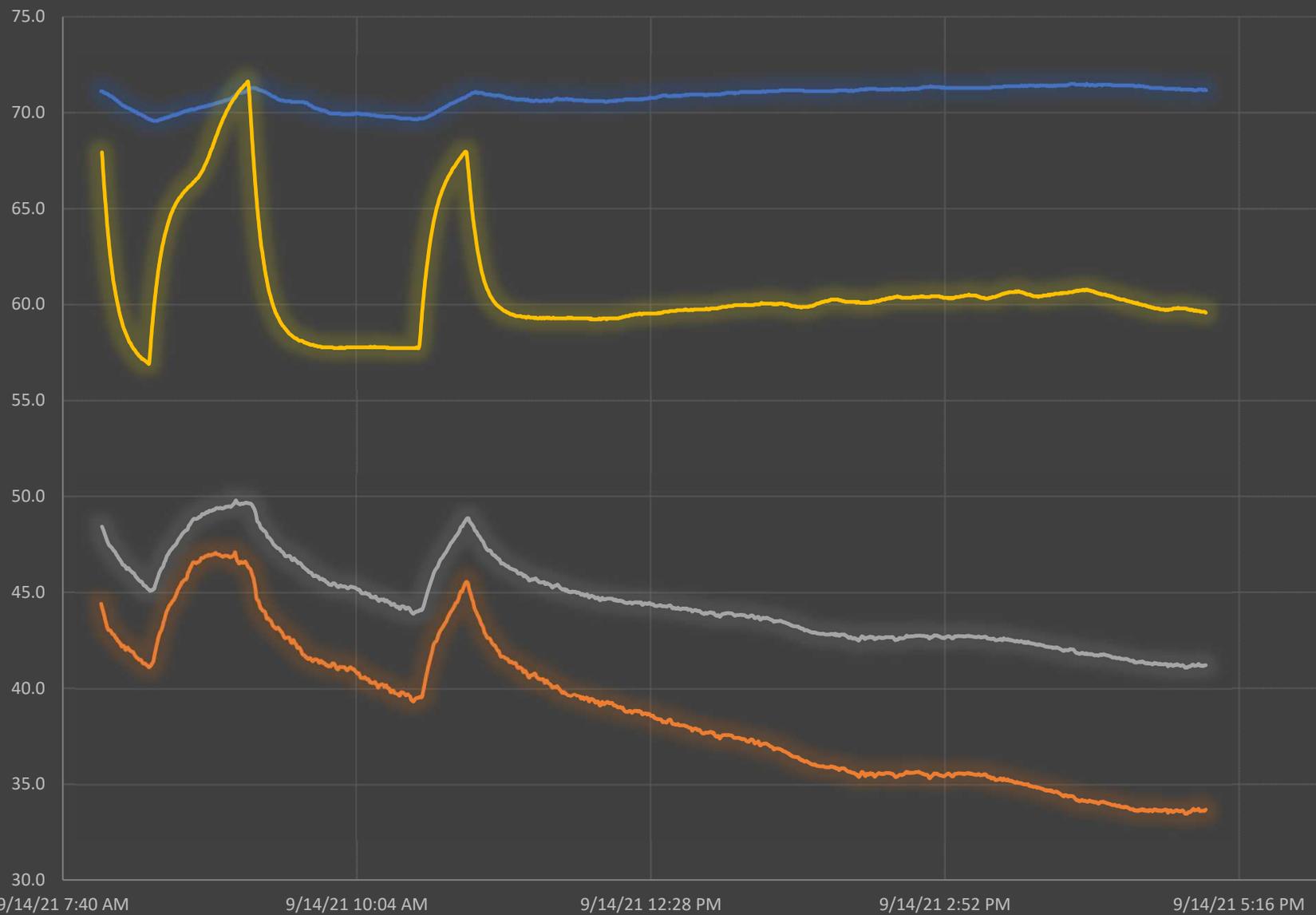
AHU-1 Dew Point Temperature Analysis 9/14/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



AHU-1 Space Conditions 9/14/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



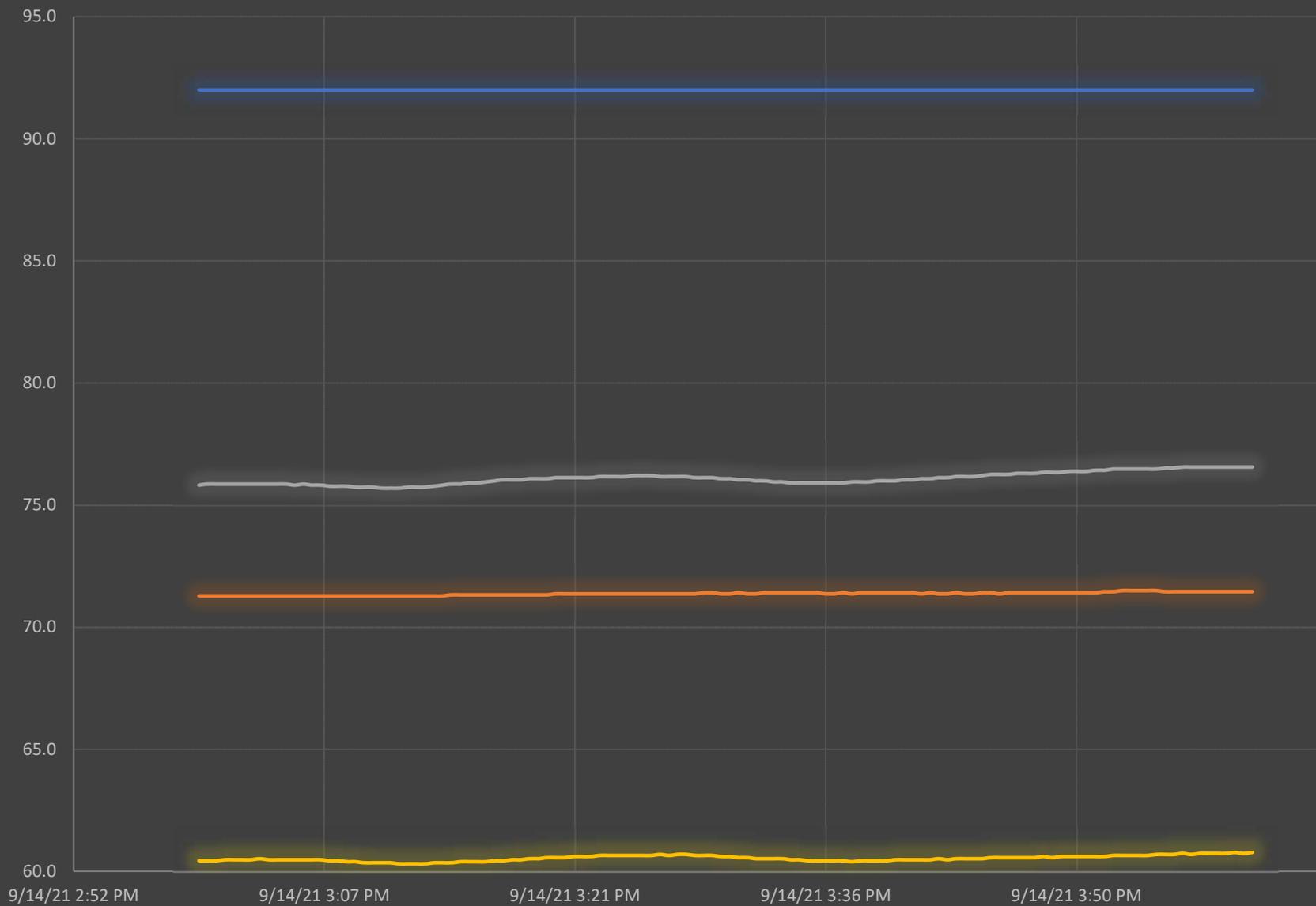
AHU-1 Space Conditions 1-Hour 9/14/2021

Spc T Spc RH Spc Dew Pt LAT



AHU-1 Dry Bulb Over 1-Hour 9/14/2021

OAT Spc T EAT LAT

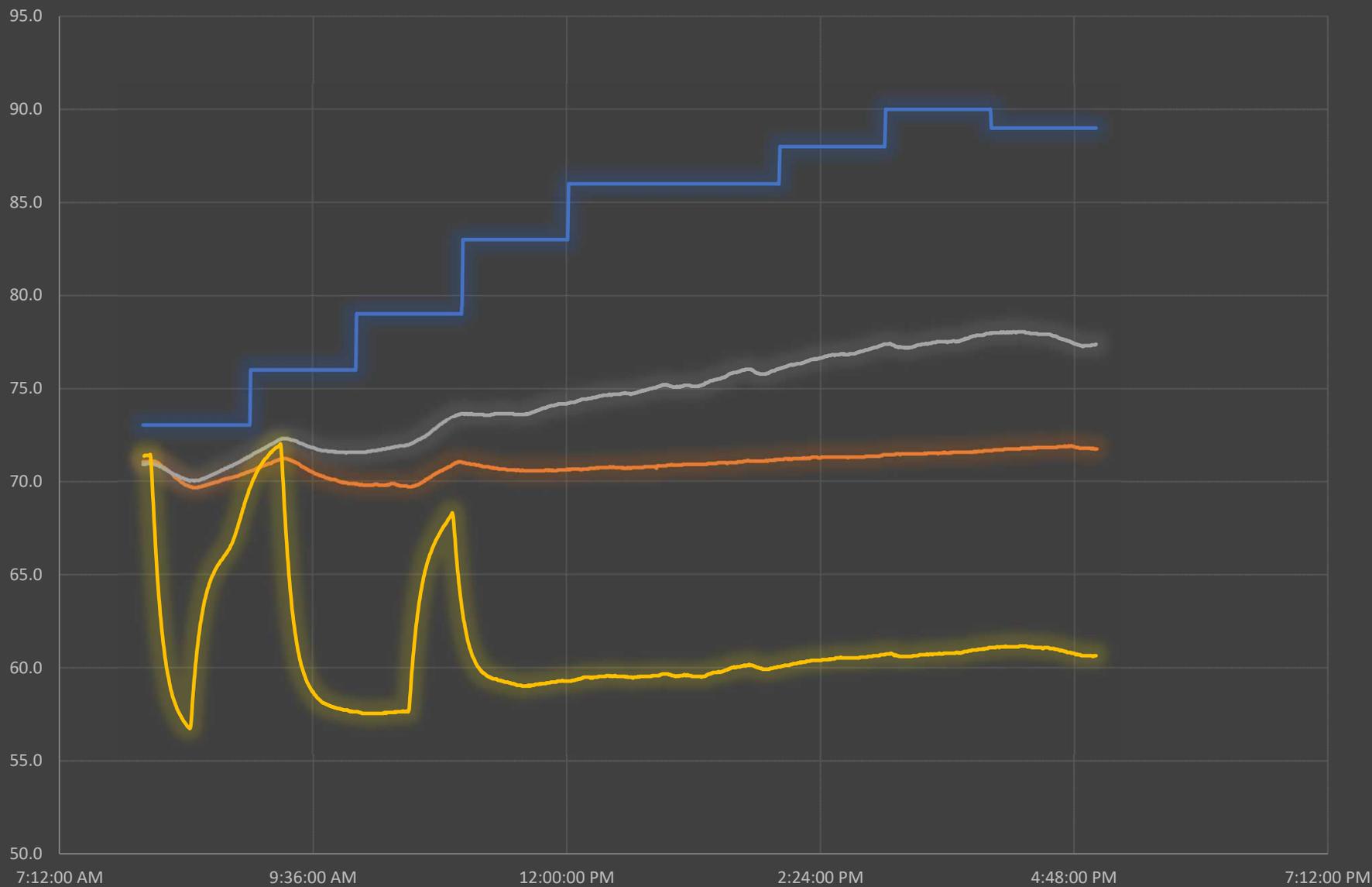


AHU-1 Data Tables

Date Time	OAT	OAH	OA-Enth	OA Dew Pt	RAT	RAH	Spc T	Spc RH	Spc Dew Pt	EAT	EAH	EA-Enth	LAT	LAH	LA-Enth	LA Dew Pt	Coil ΔT	Coil Δh	Spc vs LA Dew Pt
4:55:30 PM	89.0	45.0	35.9	65.0	72.2	35.1	71.8	31.2	39.8	77.3	31.2	25.3	60.7	45.5	20.1	44.5	16.6	5.2	-4.8
4:56:00 PM	89.0	45.0	35.9	65.0	72.2	35.1	71.8	31.3	39.8	77.3	31.3	25.4	60.7	45.5	20.1	44.6	16.6	5.2	-4.8
4:56:30 PM	89.0	45.0	35.9	65.0	72.2	35.1	71.8	31.3	39.8	77.3	31.1	25.3	60.7	45.5	20.1	44.5	16.6	5.2	-4.7
4:57:00 PM	89.0	45.0	35.9	65.0	72.2	35.0	71.8	31.3	39.8	77.3	31.2	25.3	60.7	45.4	20.1	44.5	16.6	5.2	-4.7
4:57:30 PM	89.0	45.0	35.9	65.0	72.2	35.1	71.7	31.3	39.8	77.3	31.2	25.3	60.7	45.5	20.1	44.6	16.6	5.2	-4.8
4:58:00 PM	89.0	45.0	35.9	65.0	72.2	35.1	71.8	31.3	39.8	77.3	31.2	25.4	60.7	45.5	20.1	44.6	16.7	5.3	-4.8
4:58:30 PM	89.0	45.0	35.9	65.0	72.2	35.1	71.8	31.3	39.8	77.3	31.2	25.4	60.6	45.4	20.1	44.6	16.7	5.3	-4.8
4:59:00 PM	89.0	45.0	35.9	65.0	72.2	35.1	71.7	31.3	39.8	77.3	31.2	25.4	60.6	45.5	20.1	44.6	16.7	5.3	-4.8
4:59:30 PM	89.0	45.0	35.9	65.0	72.2	35.2	71.7	31.4	39.9	77.3	31.1	25.4	60.7	45.4	20.1	44.5	16.7	5.3	-4.7
5:00:00 PM	89.0	45.0	35.9	65.0	72.2	35.2	71.7	31.3	39.8	77.3	31.2	25.4	60.7	45.5	20.1	44.6	16.7	5.3	-4.8
5:00:30 PM	89.0	45.0	35.9	65.0	72.2	35.3	71.7	31.3	39.8	77.4	31.2	25.4	60.7	45.5	20.1	44.6	16.7	5.3	-4.8

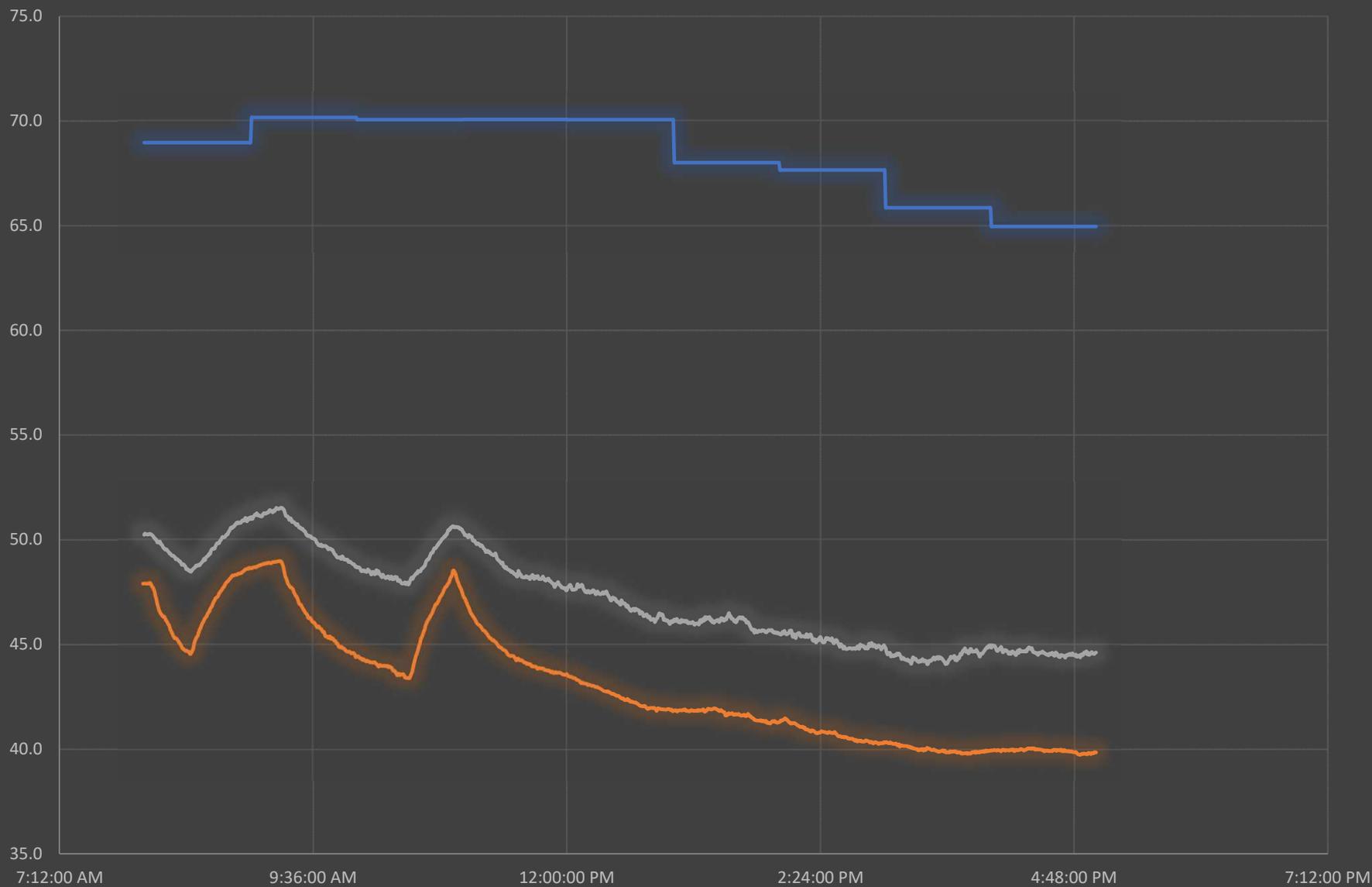
AHU-1 Dry Bulb Temperature Analysis 9/18/2021

OAT Spc T EAT LAT



AHU-1 Dew Point Temperature Analysis 9/18/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



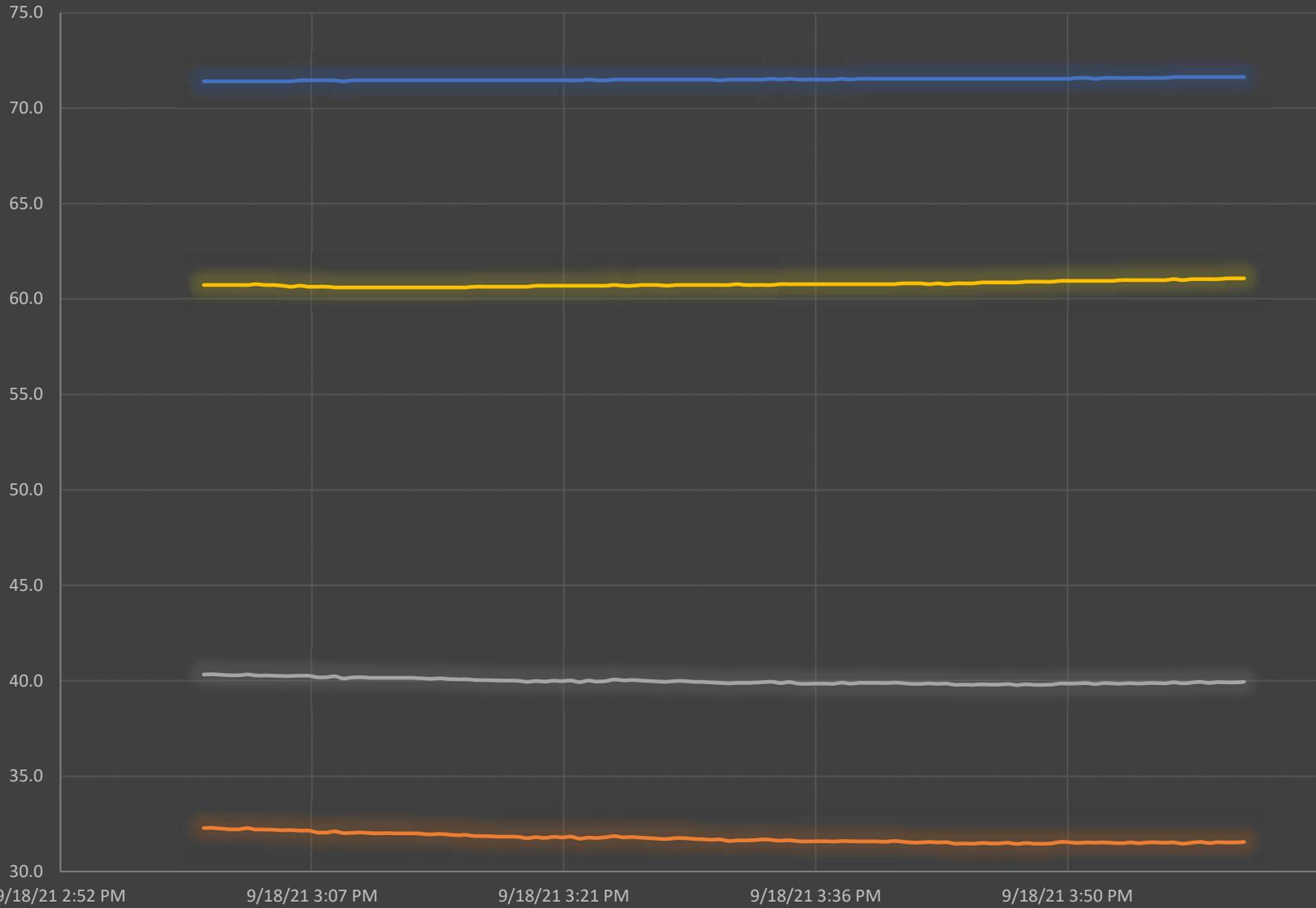
AHU-1 Space Conditions 9/18/2021

Spc T Spc RH Spc Dew Pt LAT



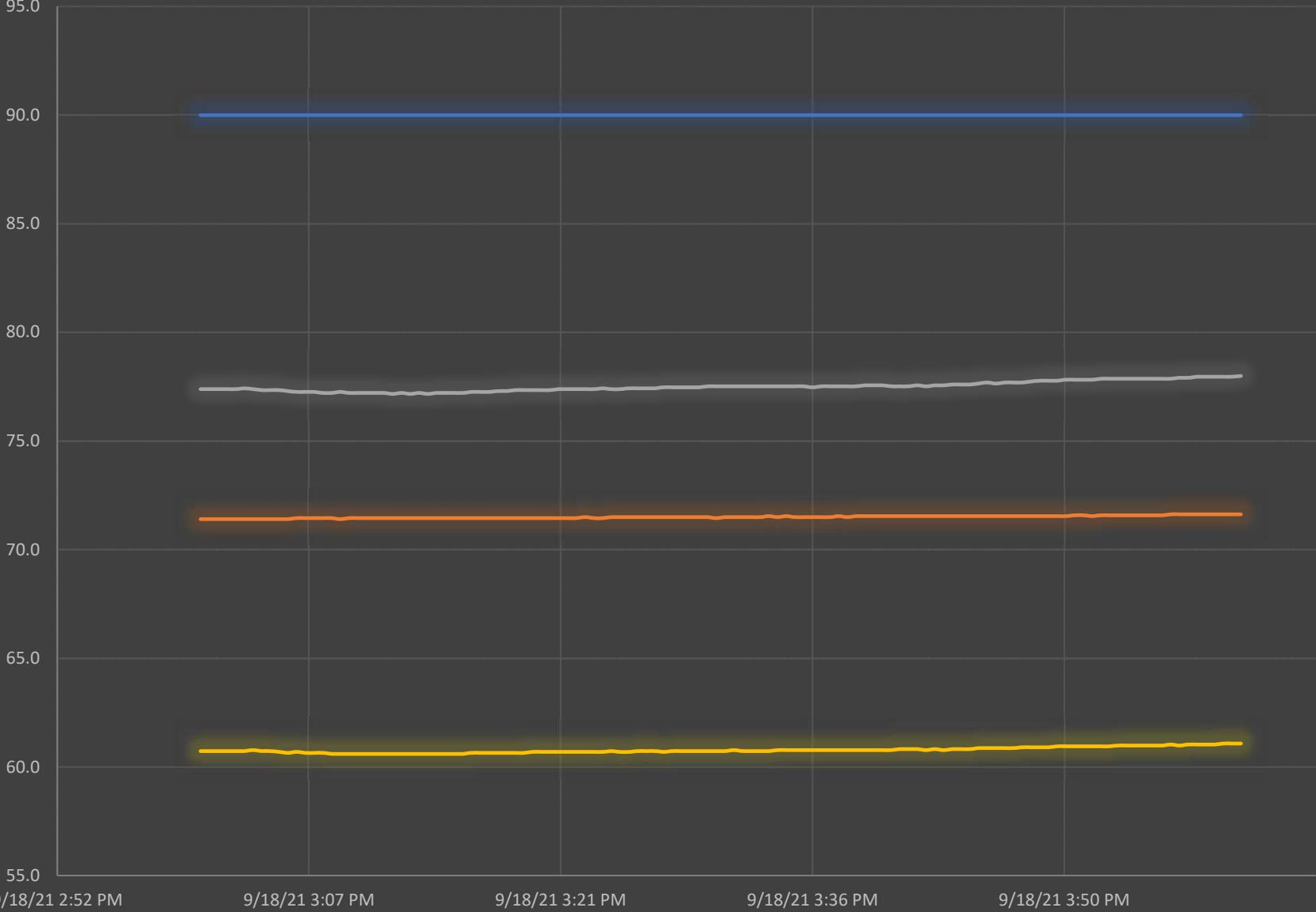
AHU-1 Space Conditions 1-Hour 9/18/2021

Spc T Spc RH Spc Dew Pt LAT



AHU-1 Dry Bulb Over 1-Hour 9/18/2021

OAT Spc T EAT LAT

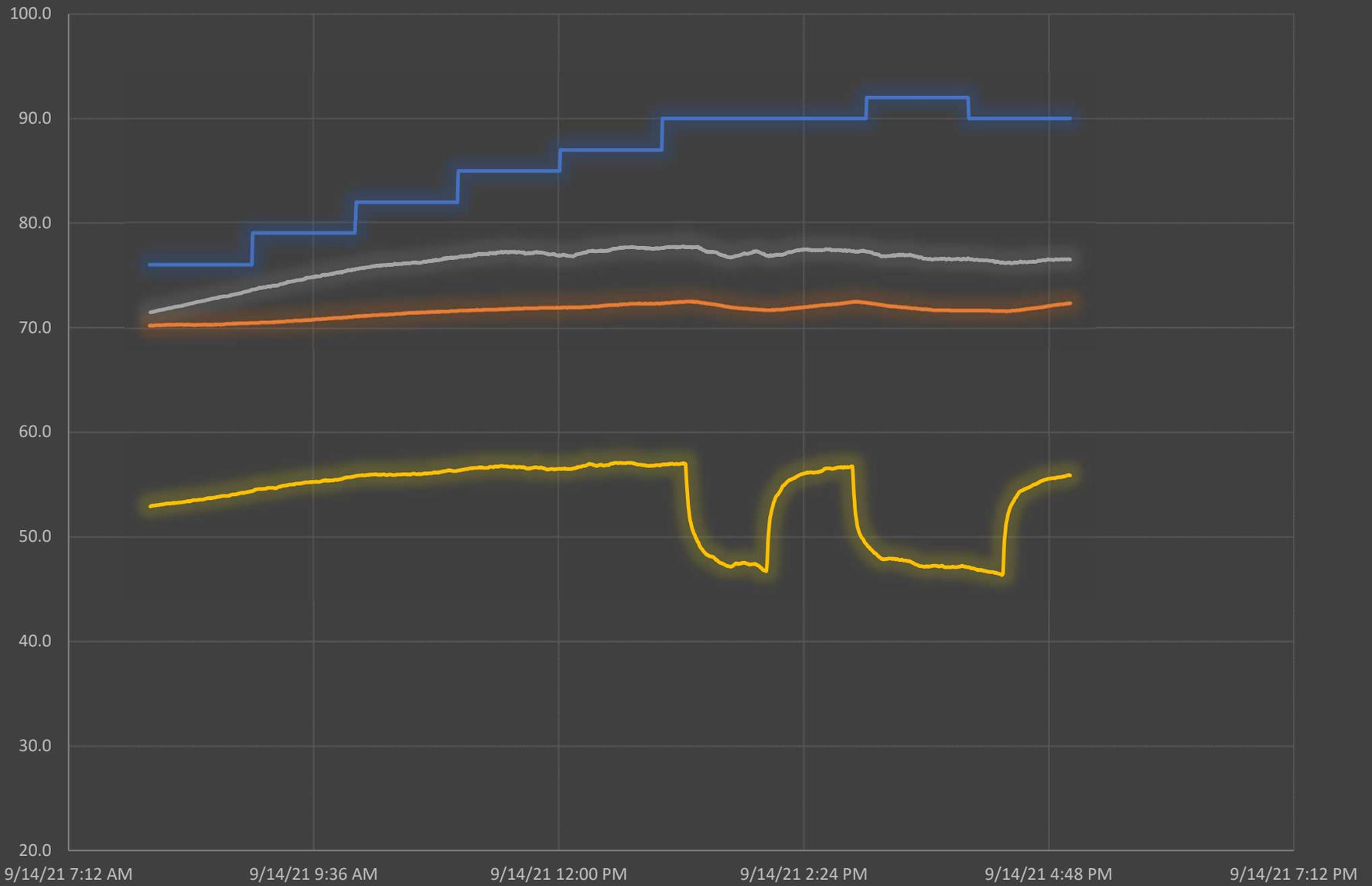


AHU-2 Data Tables

Date Time	OAT	OAH	OA-Enth	OA Dew Pt	RAT	RAH	Spc T	Spc RH	Spc Dew Pt	EAT	EAH	EA-Enth	LAT	LAH	LA-Enth	LA Dew Pt	Coil ΔT	Coil Δh	Spc vs LA Dew Pt
9/14/21 4:55 PM	90.0	46.0	36.9	66.5	72.3	44.2	72.3	44.2	49.3	76.6	41.4	27.2	55.7	89.4	22.6	51.4	20.8	4.6	-2.1
9/14/21 4:56 PM	90.0	46.0	36.9	66.5	72.3	44.3	72.3	44.3	49.4	76.5	41.4	27.2	55.7	89.4	22.6	51.4	20.8	4.6	-2.0
9/14/21 4:56 PM	90.0	46.0	36.9	66.5	72.3	44.3	72.3	44.3	49.4	76.5	41.4	27.2	55.8	89.4	22.6	51.4	20.7	4.6	-2.0
9/14/21 4:57 PM	90.0	46.0	36.9	66.5	72.3	44.3	72.3	44.3	49.5	76.6	41.7	27.3	55.8	89.6	22.6	51.6	20.8	4.7	-2.2
9/14/21 4:57 PM	90.0	46.0	36.9	66.5	72.3	44.4	72.3	44.4	49.5	76.6	41.8	27.3	55.8	89.6	22.6	51.7	20.8	4.7	-2.2
9/14/21 4:58 PM	90.0	46.0	36.9	66.5	72.3	44.4	72.3	44.4	49.5	76.6	41.8	27.3	55.8	89.6	22.6	51.7	20.7	4.7	-2.2
9/14/21 4:58 PM	90.0	46.0	36.9	66.5	72.3	44.5	72.3	44.5	49.6	76.5	41.8	27.2	55.9	89.6	22.6	51.6	20.6	4.6	-2.1
9/14/21 4:59 PM	90.0	46.0	36.9	66.5	72.4	44.5	72.4	44.5	49.6	76.6	41.9	27.3	55.9	89.6	22.6	51.8	20.7	4.7	-2.2
9/14/21 4:59 PM	90.0	46.0	36.9	66.5	72.4	44.5	72.4	44.5	49.6	76.6	42.0	27.3	55.9	89.7	22.7	51.9	20.6	4.6	-2.3
9/14/21 5:00 PM	90.0	46.0	36.9	66.5	72.4	44.6	72.4	44.6	49.6	76.6	42.0	27.3	55.9	89.7	22.7	51.8	20.6	4.6	-2.2
9/14/21 5:00 PM	90.0	46.0	36.9	66.5	72.4	44.6	72.4	44.6	49.7	76.5	41.9	27.3	55.9	89.6	22.6	51.8	20.6	4.6	-2.1

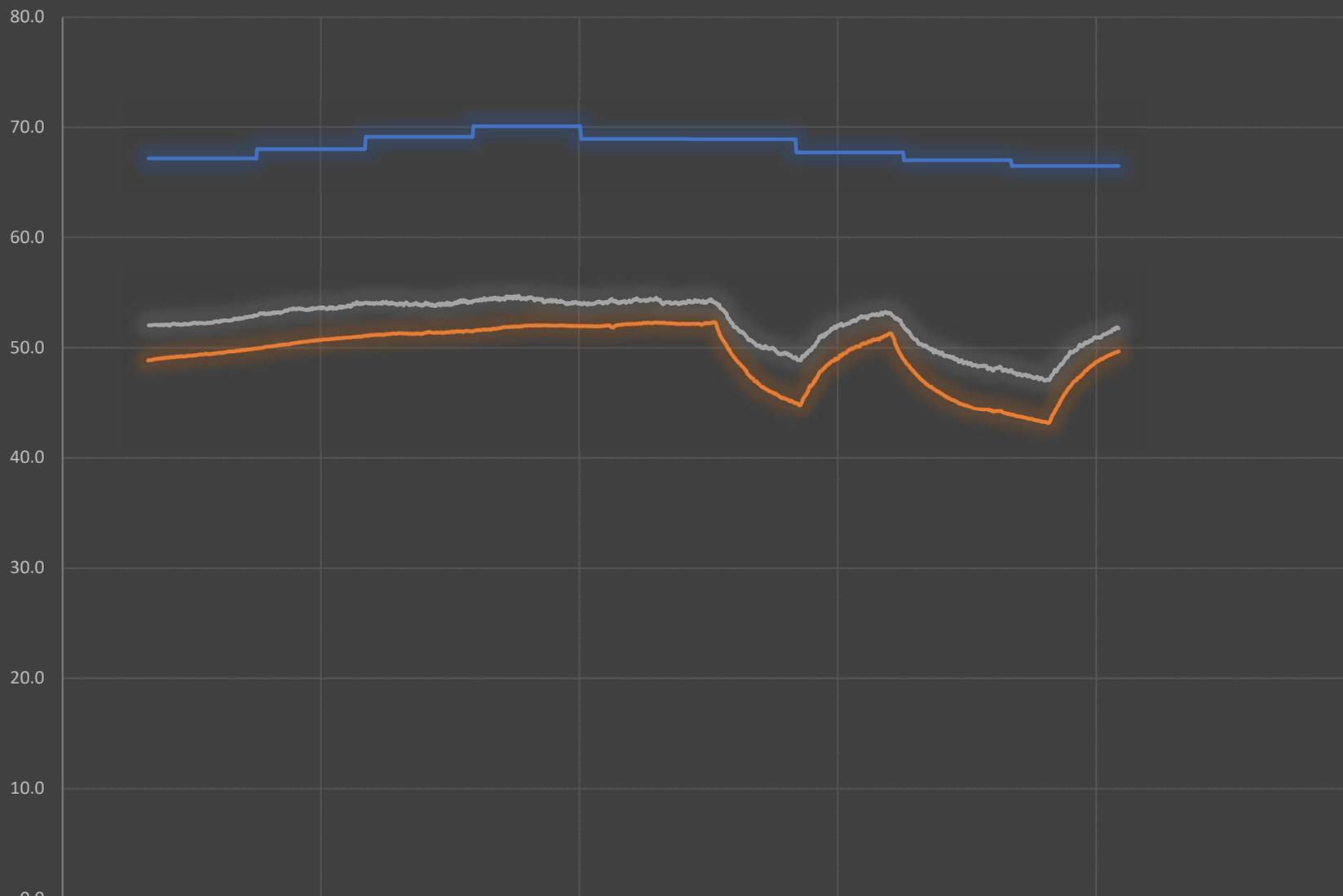
AHU-2 Space Conditions 1-Hour 9/14/2021

OAT Spc T EAT LAT



AHU-2 Dew Point Temperature Analysis 9/14/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



9/14/21 7:12 AM

9/14/21 9:36 AM

9/14/21 12:00 PM

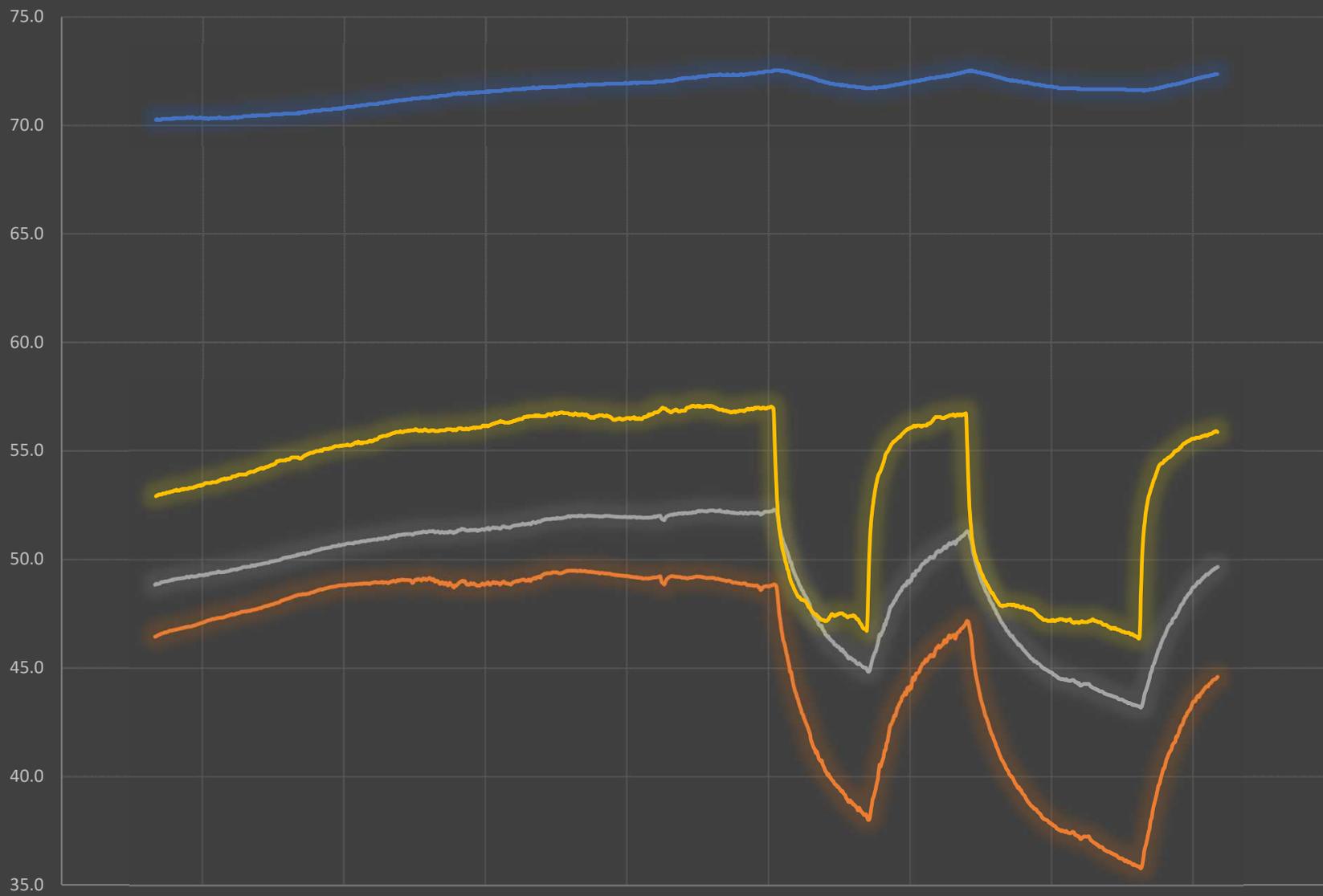
9/14/21 2:24 PM

9/14/21 4:48 PM

9/14/21 7:12 PM

AHU-2 Space Conditions 9/14/2021

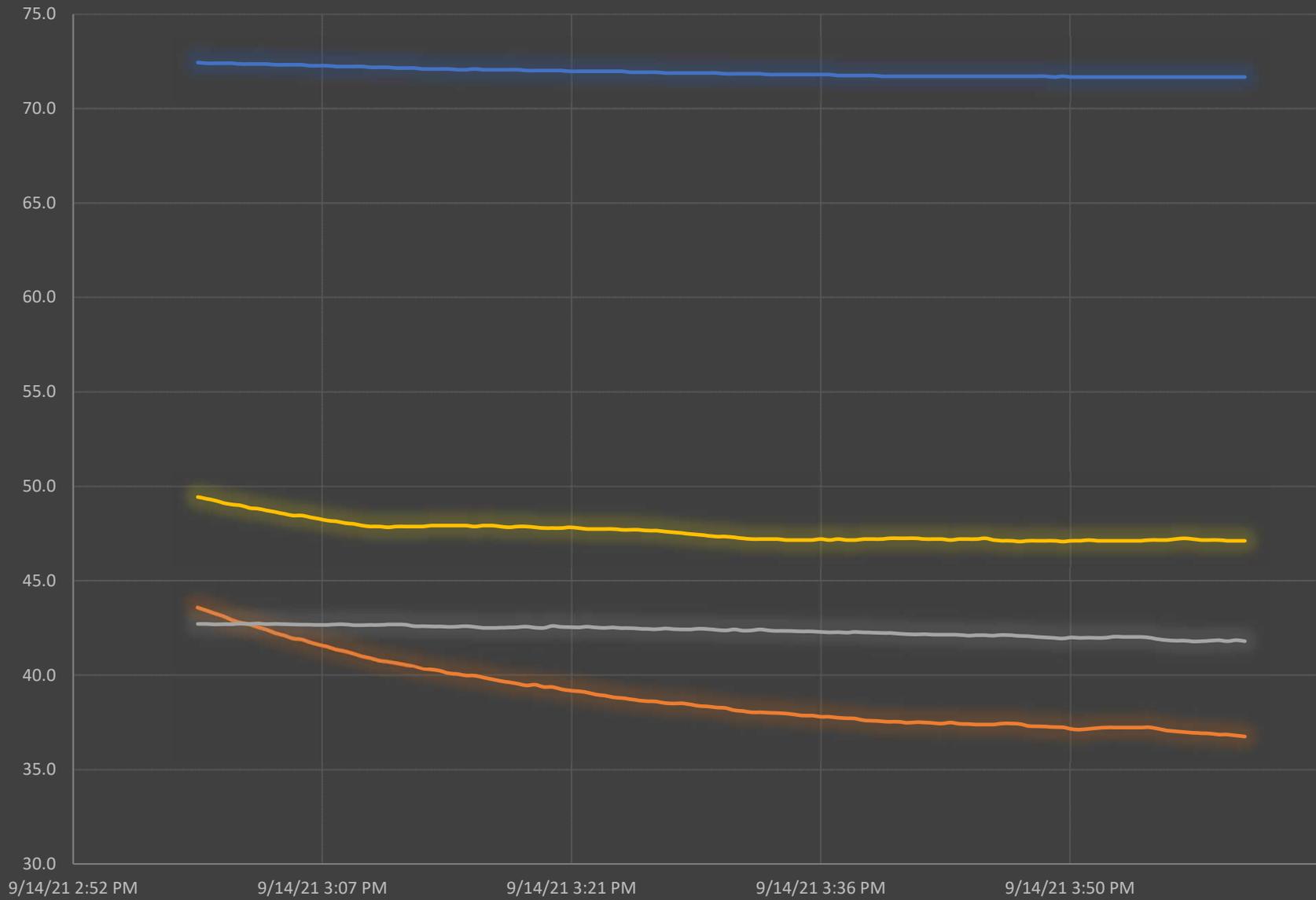
— Spc T — Spc RH — Spc Dew Pt — LAT



9/14/21 7:12 AM 9/14/21 8:24 AM 9/14/21 9:36 AM 9/14/21 10:48 AM 9/14/21 12:00 PM 9/14/21 1:12 PM 9/14/21 2:24 PM 9/14/21 3:36 PM 9/14/21 4:48 PM 9/14/21 6:00 PM

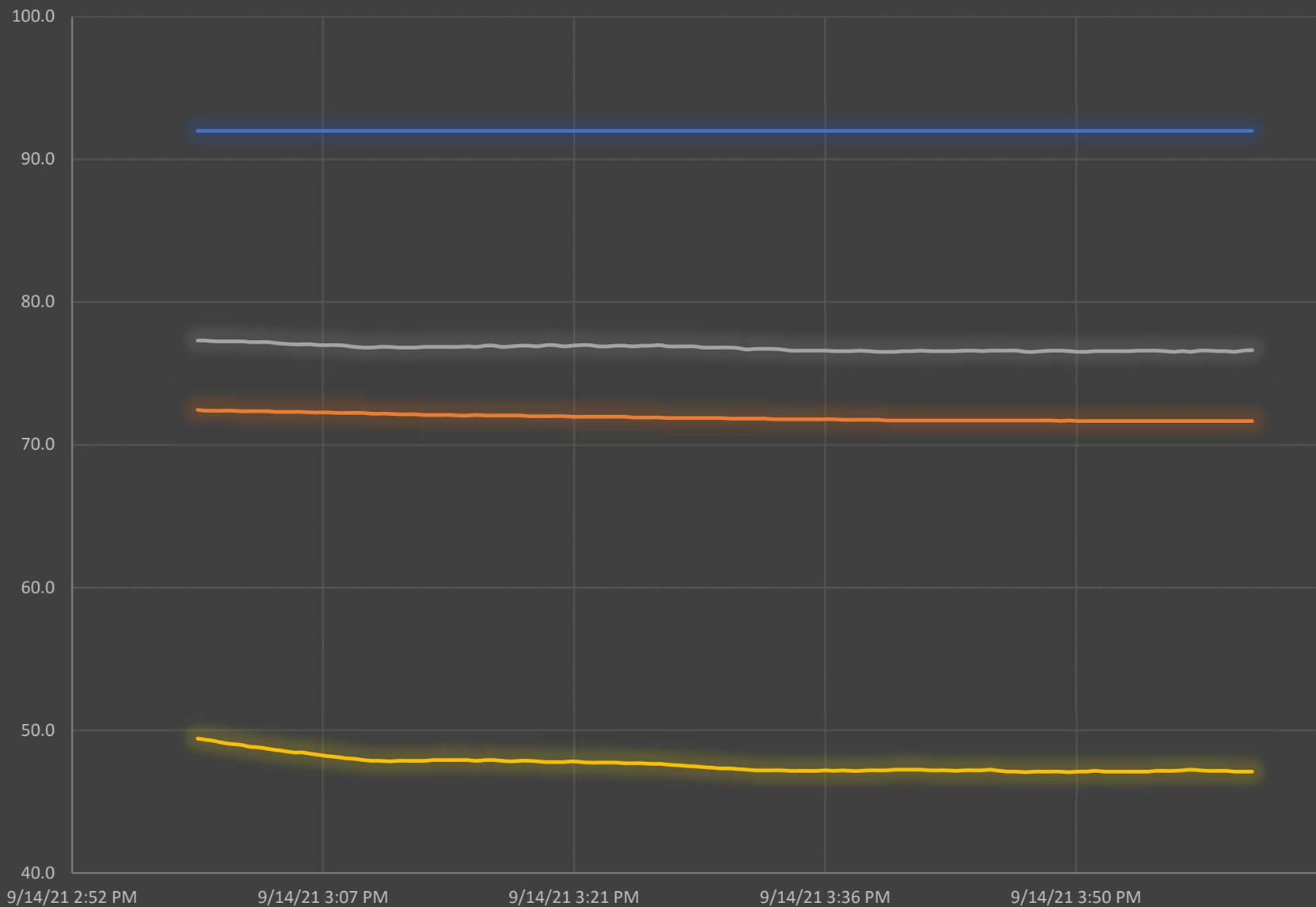
AHU-2 Space Conditions 1-Hour 9/14/2021

Spc T Spc RH Spc Dew Pt LAT



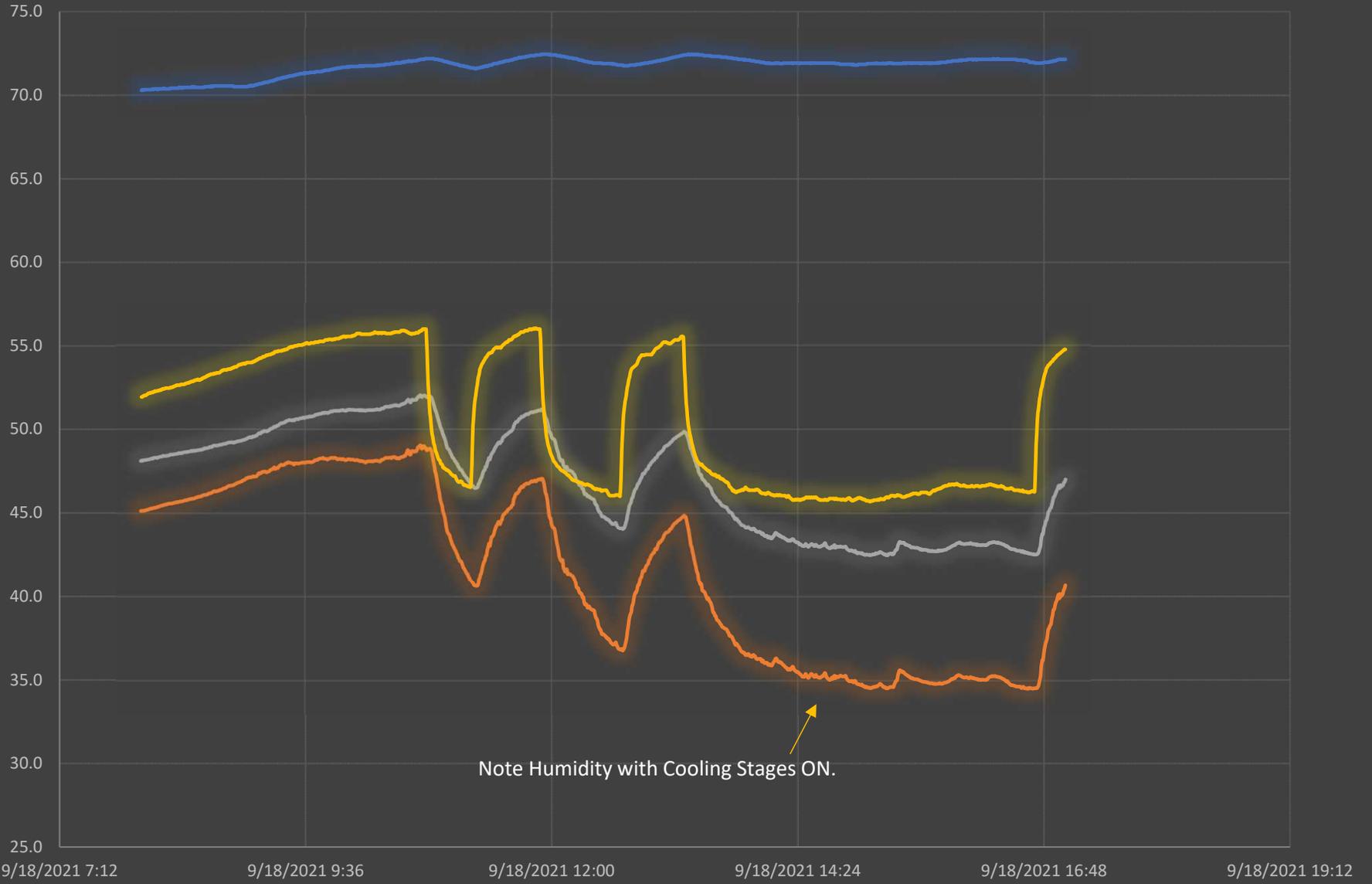
AHU-2 Dry Bulb Over 1-Hour 9/14/2021

OAT Spc T EAT LAT



AHU-2 Space Conditions 9/18/2021

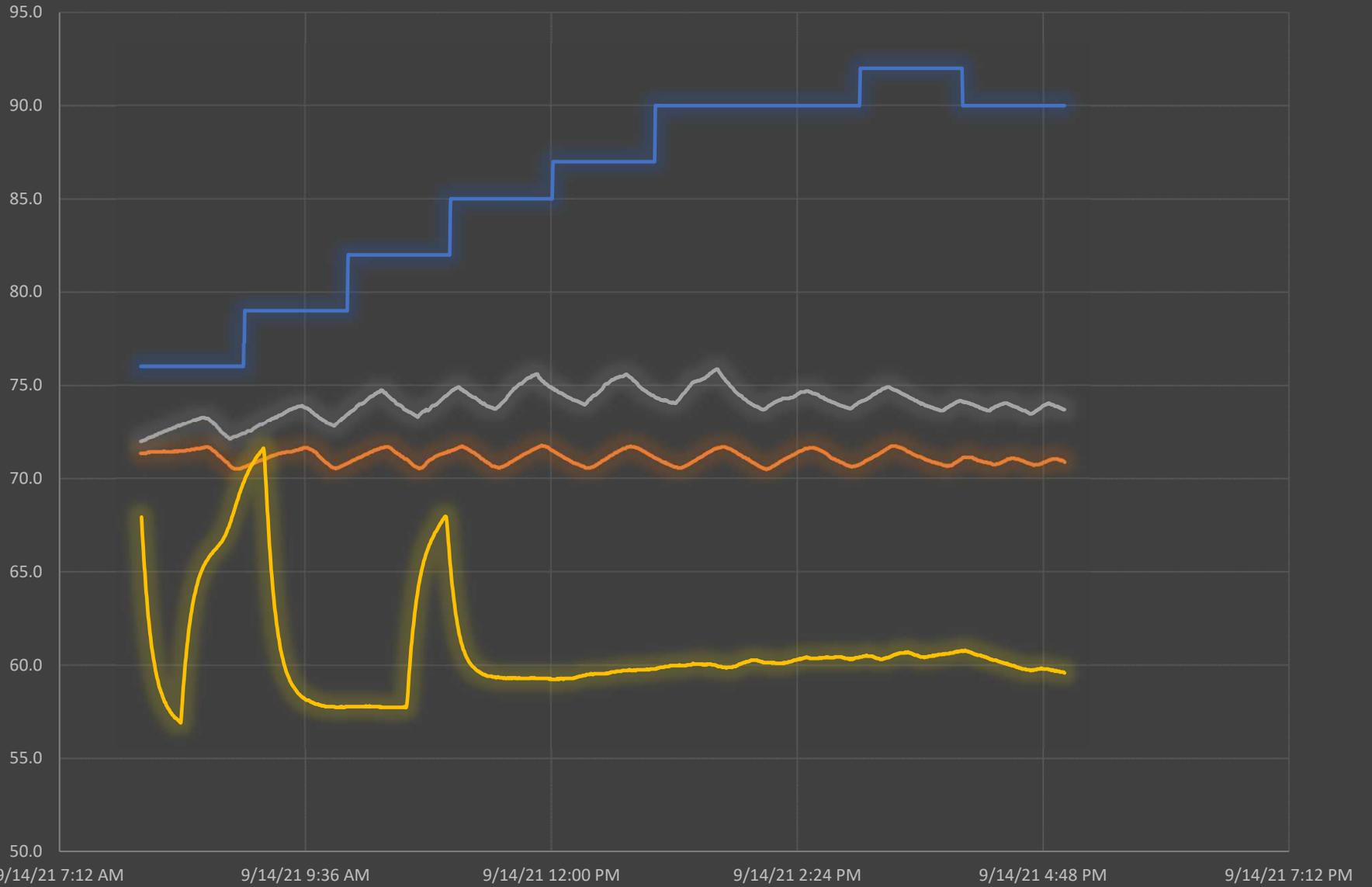
— Spc T — Spc RH — Spc Dew Pt — LAT



APPENDIX D - SULLIVAN DATA TABLES & CHARTS

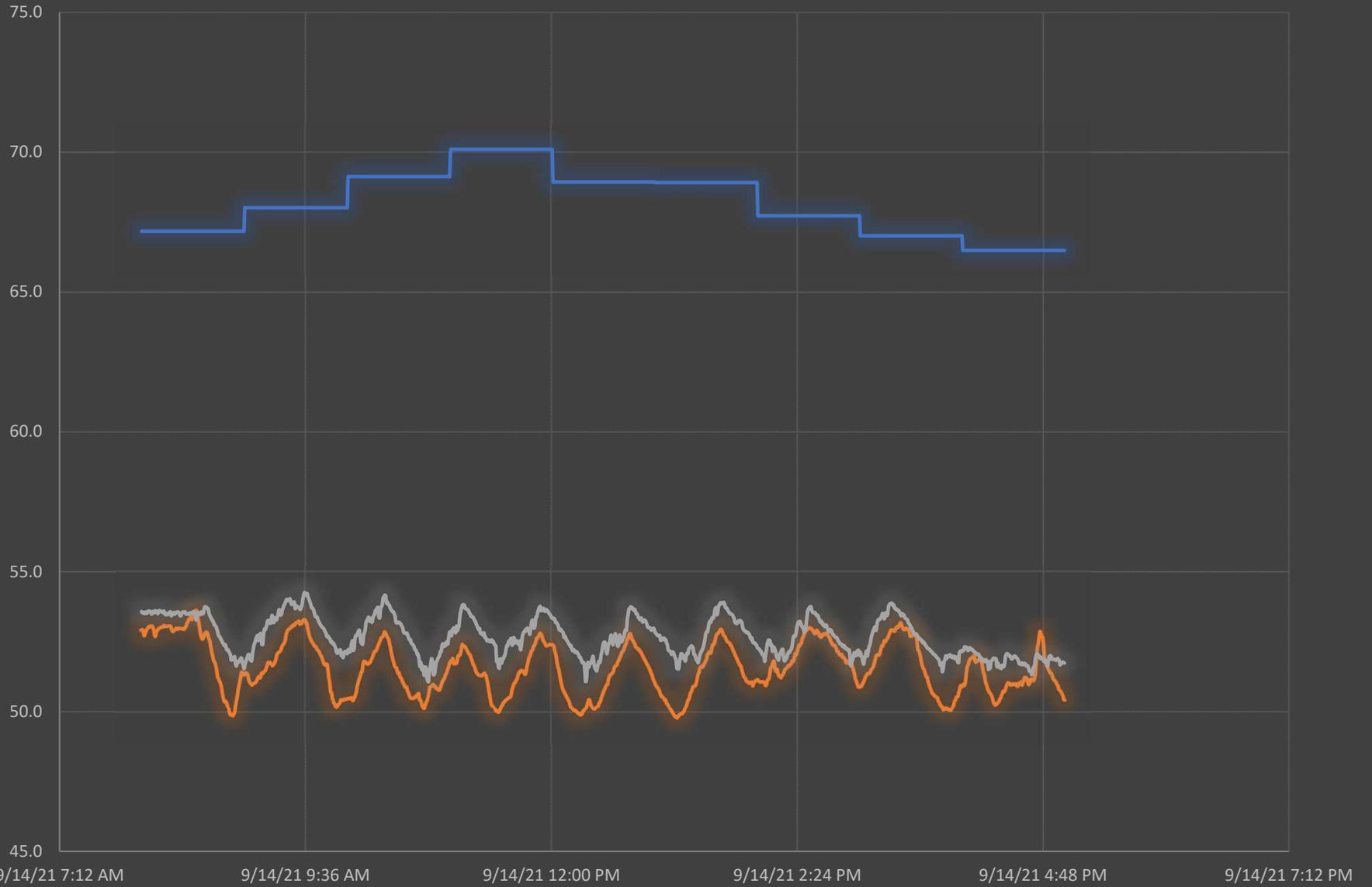
AHU-1 Space Conditions 1-Hour 9/14/2021

OAT Spc T EAT LAT



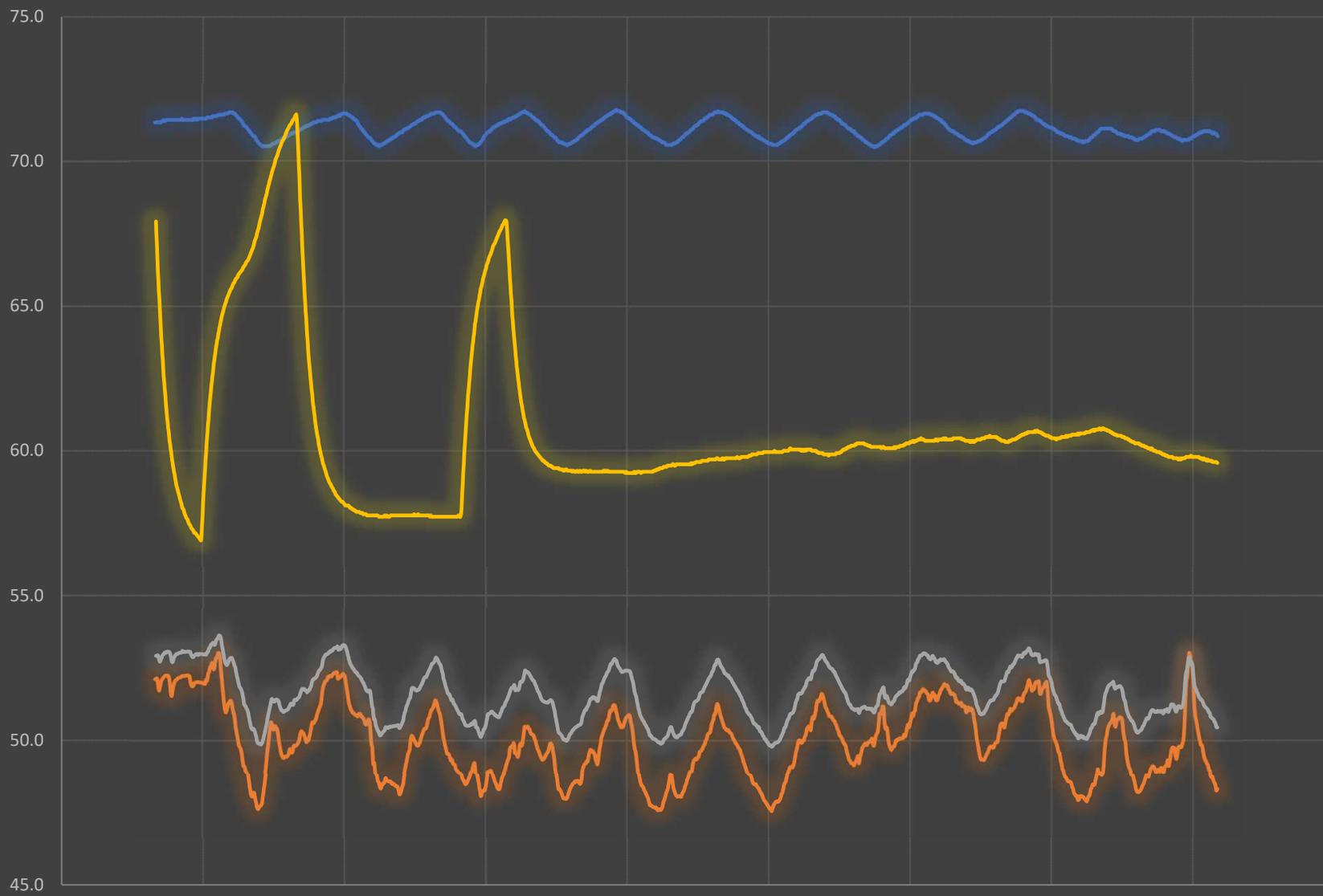
AHU-1 Dew Point Temperature Analysis 9/14/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



AHU-1 Space Conditions 9/14/2021

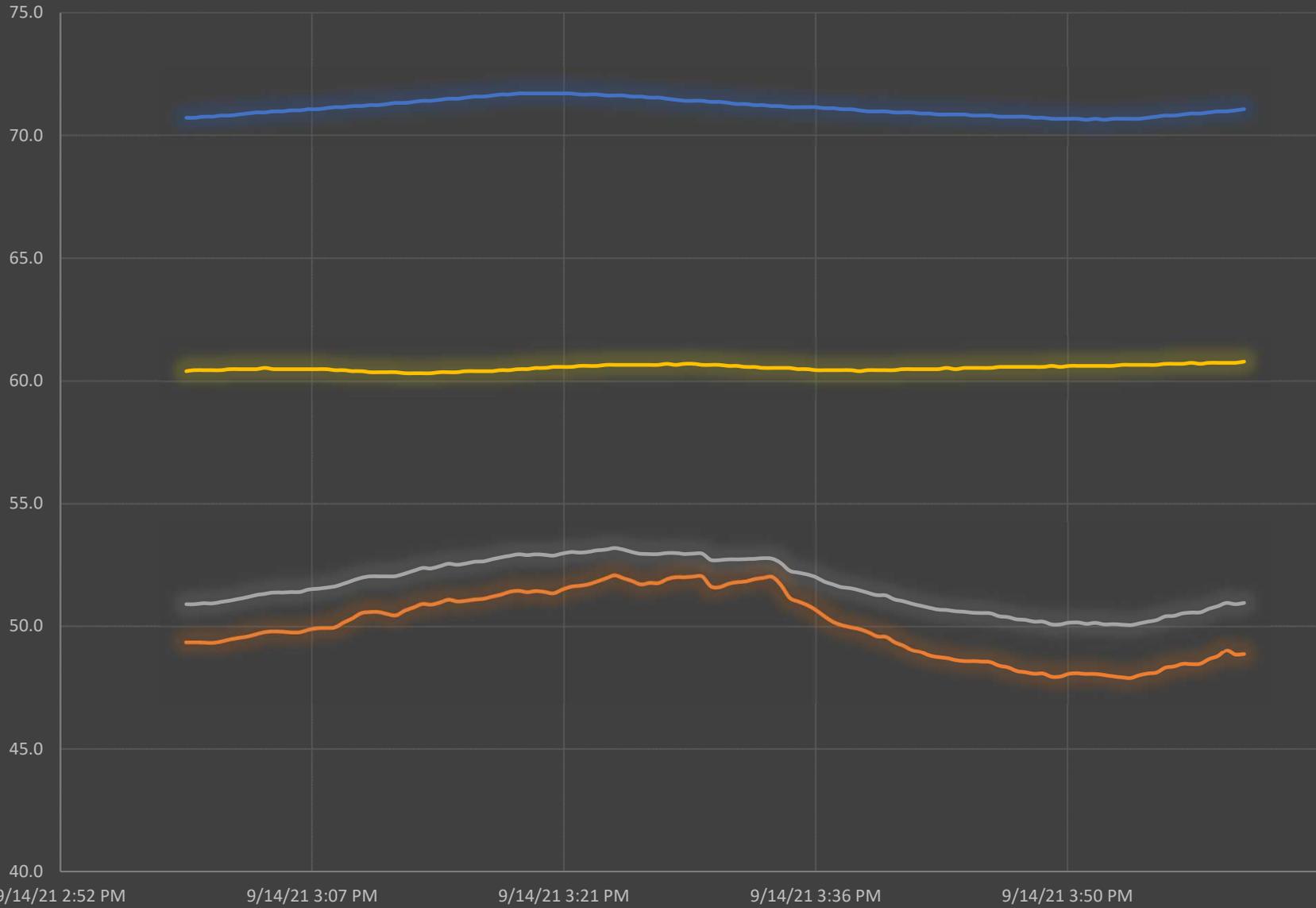
— Spc T — Spc RH — Spc Dew Pt — LAT



9/14/21 7:12 AM 9/14/21 8:24 AM 9/14/21 9:36 AM 9/14/21 10:48 AM 9/14/21 12:00 PM 9/14/21 1:12 PM 9/14/21 2:24 PM 9/14/21 3:36 PM 9/14/21 4:48 PM 9/14/21 6:00 PM

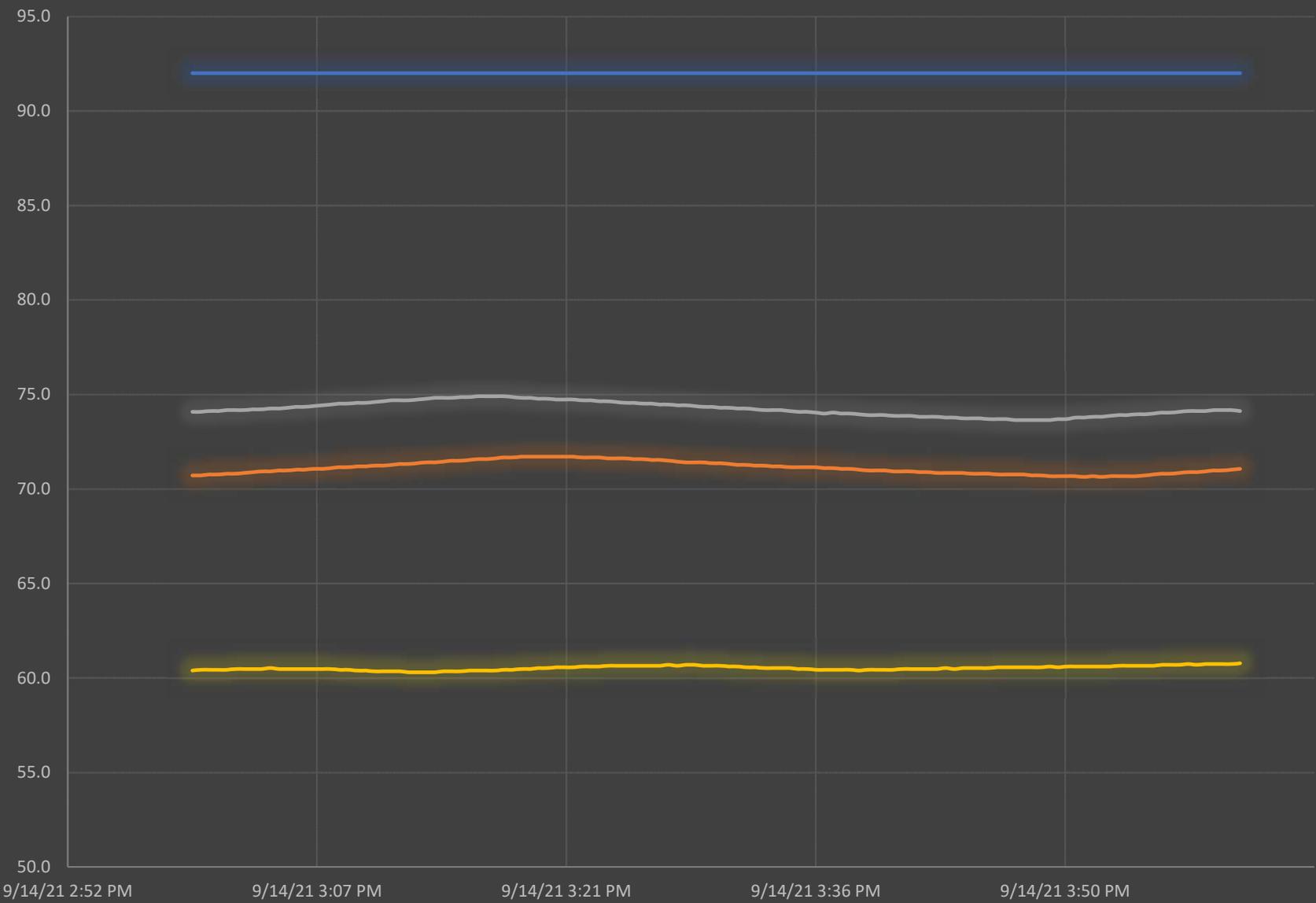
AHU-1 Space Conditions 1-Hour 9/14/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



AHU-1 Dry Bulb Over 1-Hour 9/14/2021

OAT Spc T EAT LAT

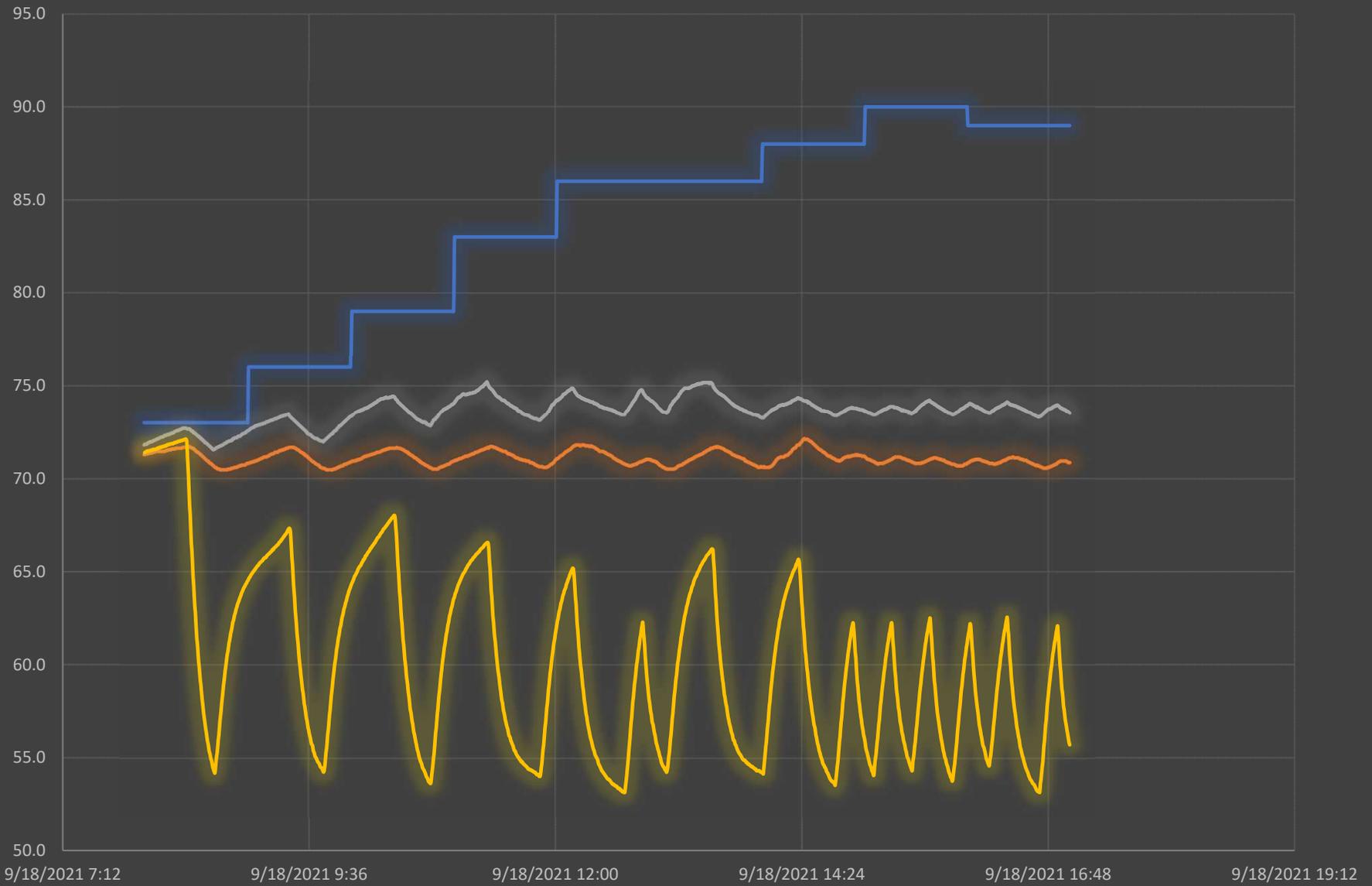


AHU-1 Data Tables

Date Time	OAT	OAH	OA-Enth	OA Dew Pt	RAT	RAH	Spc T	Spc RH	Spc Dew Pt	EAT	EAH	EA-Enth	LAT	LAH	LA-Enth	LA Dew Pt	Coil ΔT	Coil Δh	Spc vs LA Dew Pt
9/18/2021 16:55	89.0	45.0	35.9	65.0	73.0	43.9	70.9	48.8	50.8	73.8	46.2	26.7	59.3	78.8	23.5	51.9	14.5	3.2	-1.1
9/18/2021 16:56	89.0	45.0	35.9	65.0	73.0	43.9	70.9	48.9	50.9	73.8	46.2	26.7	58.7	72.9	22.4	51.9	15.1	4.2	-1.0
9/18/2021 16:56	89.0	45.0	35.9	65.0	73.0	44.0	70.9	49.4	51.1	73.7	46.2	26.7	58.3	68.5	21.7	51.9	15.5	5.0	-0.8
9/18/2021 16:57	89.0	45.0	35.9	65.0	73.0	43.9	70.9	49.5	51.2	73.7	46.2	26.7	57.8	65.6	21.1	51.9	16.0	5.6	-0.7
9/18/2021 16:57	89.0	45.0	35.9	65.0	73.0	43.8	70.9	49.6	51.2	73.7	46.3	26.6	57.4	63.9	20.7	51.9	16.3	5.9	-0.7
9/18/2021 16:58	89.0	45.0	35.9	65.0	73.0	43.7	70.9	49.6	51.2	73.7	46.4	26.7	57.0	63.2	20.5	51.9	16.7	6.2	-0.7
9/18/2021 16:58	89.0	45.0	35.9	65.0	73.0	43.7	70.9	49.6	51.2	73.7	46.4	26.6	56.7	62.8	20.3	51.9	16.9	6.4	-0.7
9/18/2021 16:59	89.0	45.0	35.9	65.0	73.0	43.6	70.9	49.7	51.2	73.6	46.4	26.6	56.5	62.7	20.1	51.9	17.1	6.5	-0.6
9/18/2021 16:59	89.0	45.0	35.9	65.0	73.0	43.6	70.9	49.8	51.2	73.6	46.5	26.6	56.2	62.9	20.0	51.9	17.4	6.6	-0.7
9/18/2021 17:00	89.0	45.0	35.9	65.0	72.9	43.5	70.9	49.8	51.2	73.6	46.5	26.6	55.9	63.1	19.9	51.9	17.7	6.7	-0.6
9/18/2021 17:00	89.0	45.0	35.9	65.0	72.9	43.5	70.9	49.6	51.2	73.5	46.5	26.6	55.7	63.3	19.8	51.8	17.8	6.8	-0.7

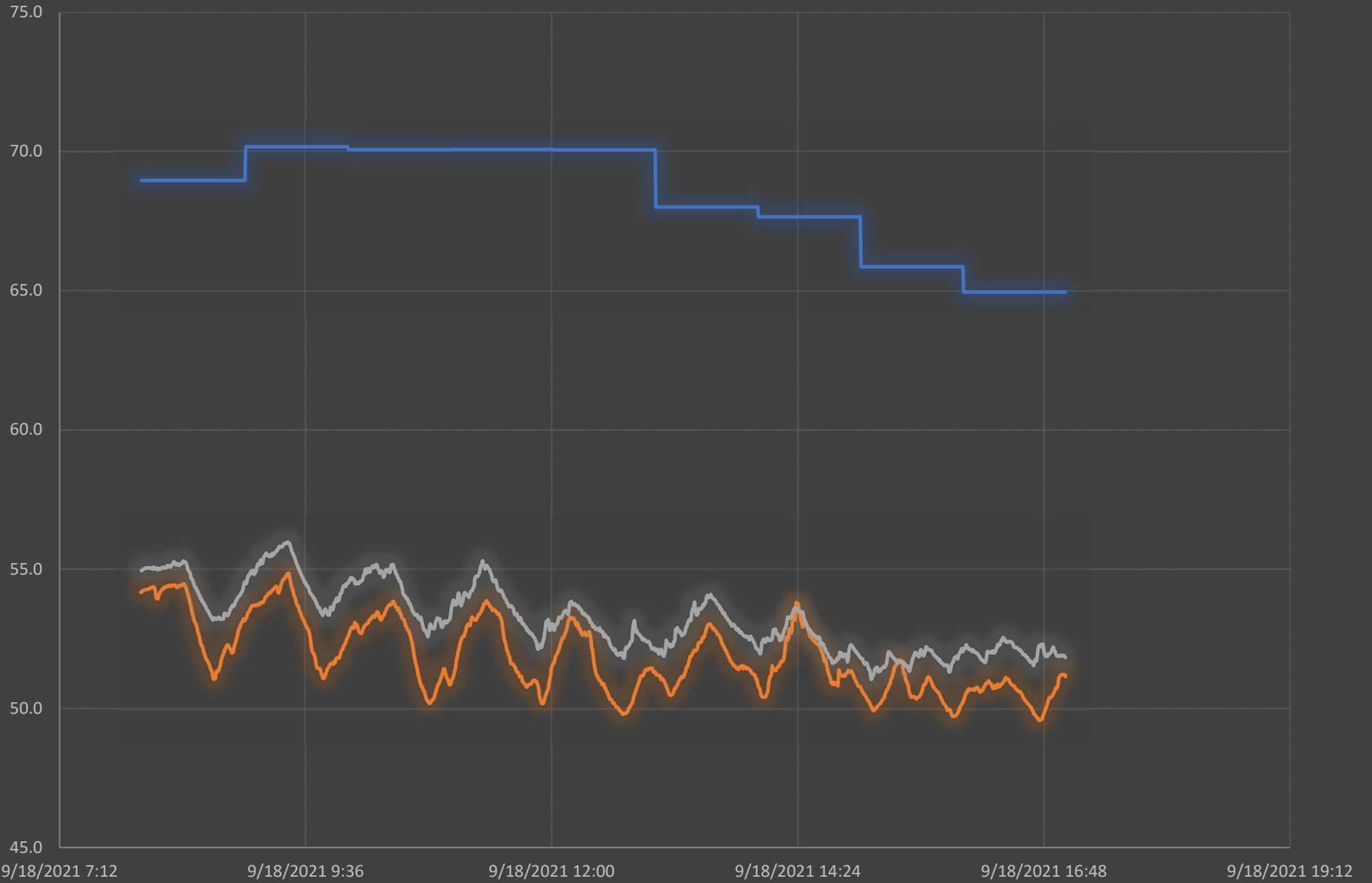
AHU-1 Dry Bulb Temperature Analysis 9/18/2021

OAT Spc T EAT LAT



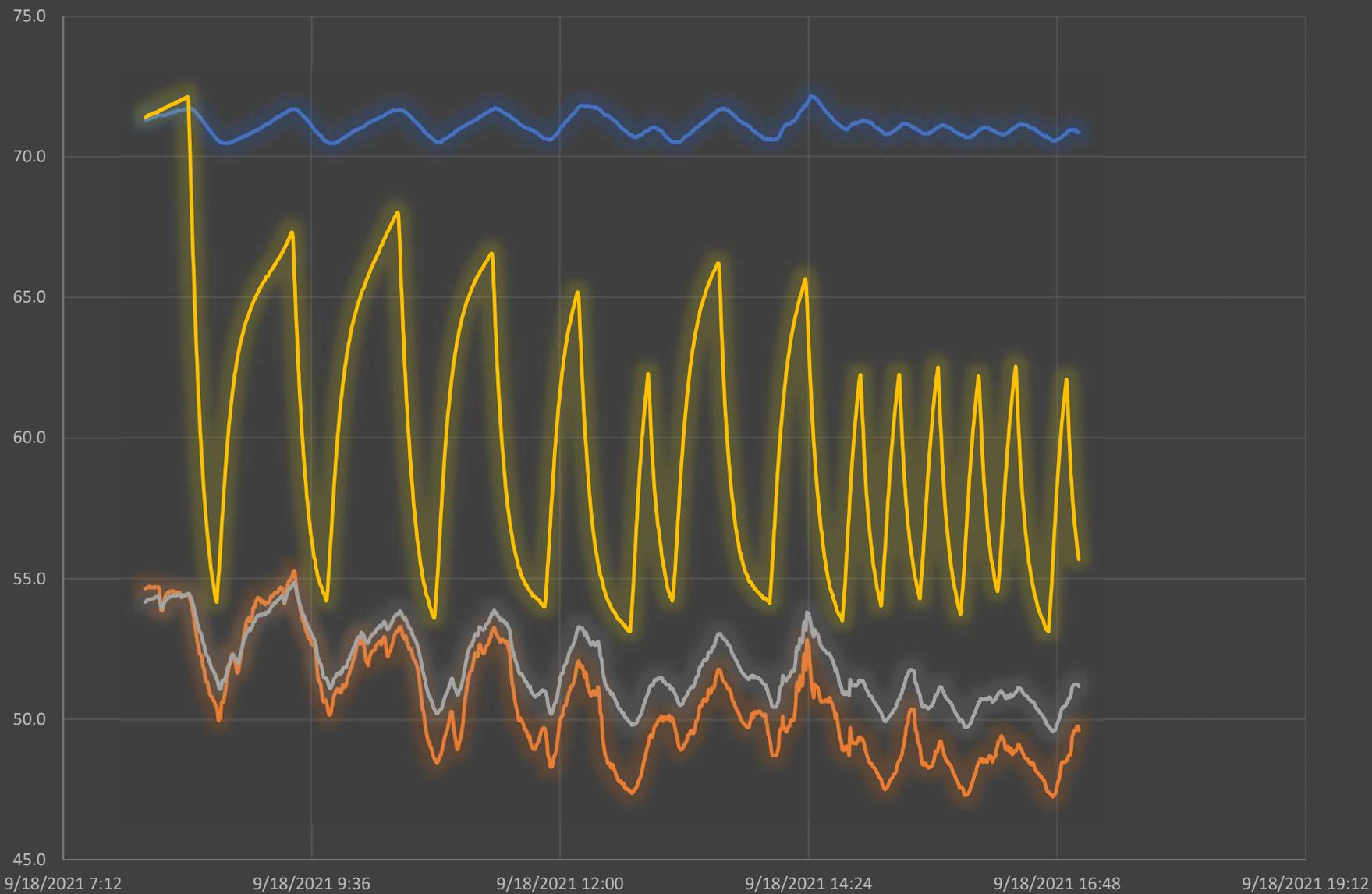
AHU-1 Dew Point Temperature Analysis 9/18/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



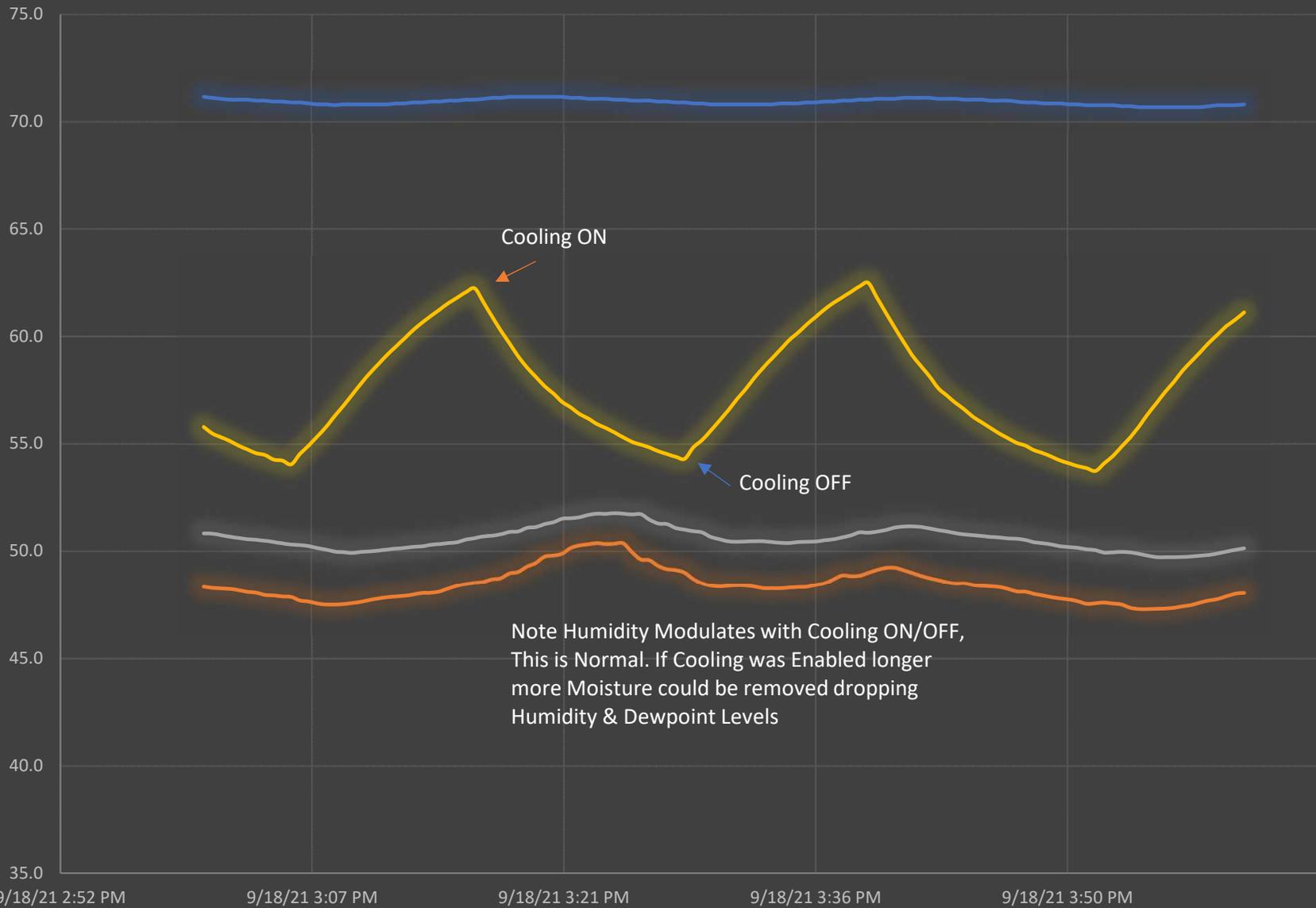
AHU-1 Space Conditions 9/18/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



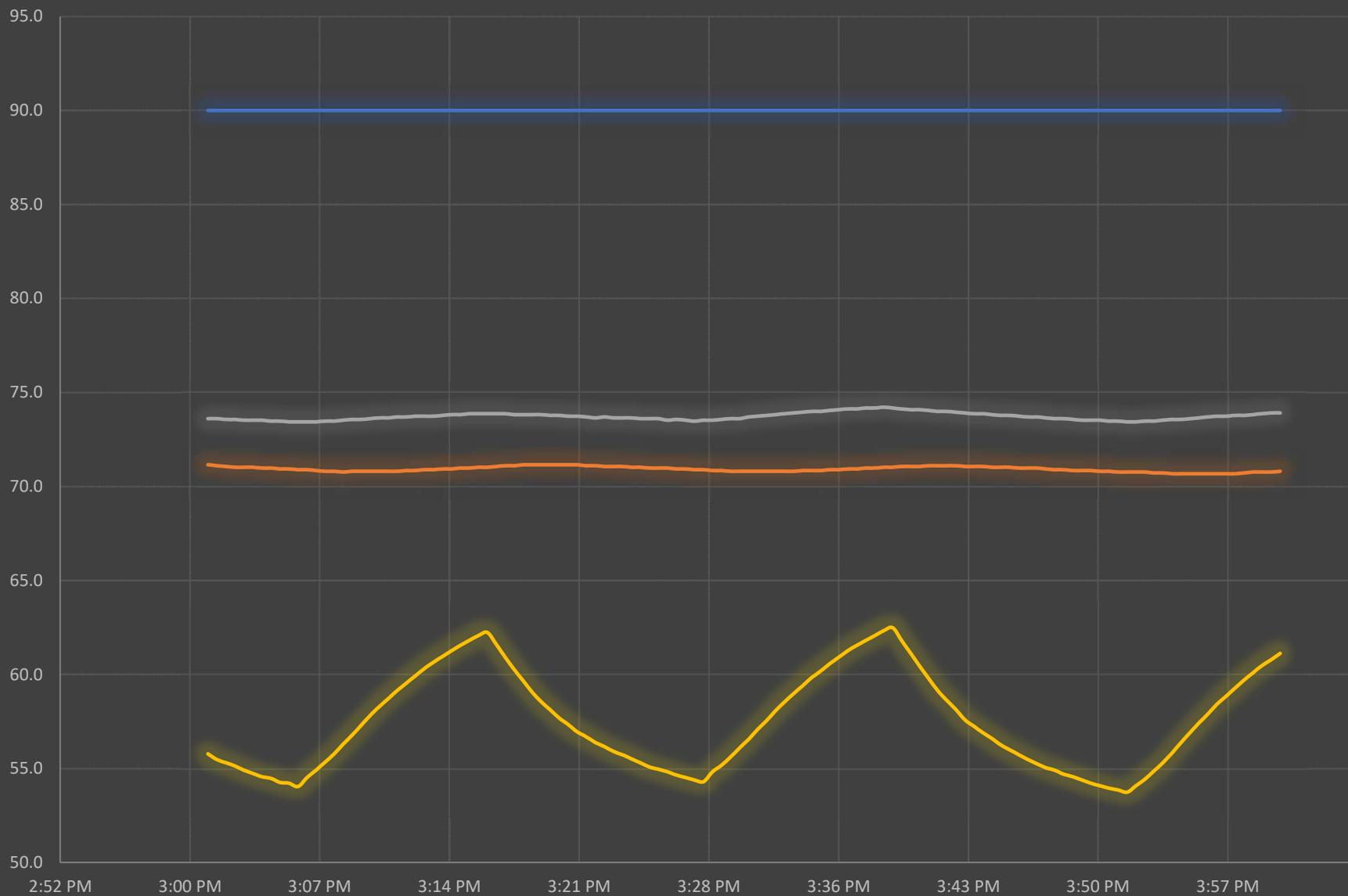
AHU-1 Space Conditions 1-Hour 9/18/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



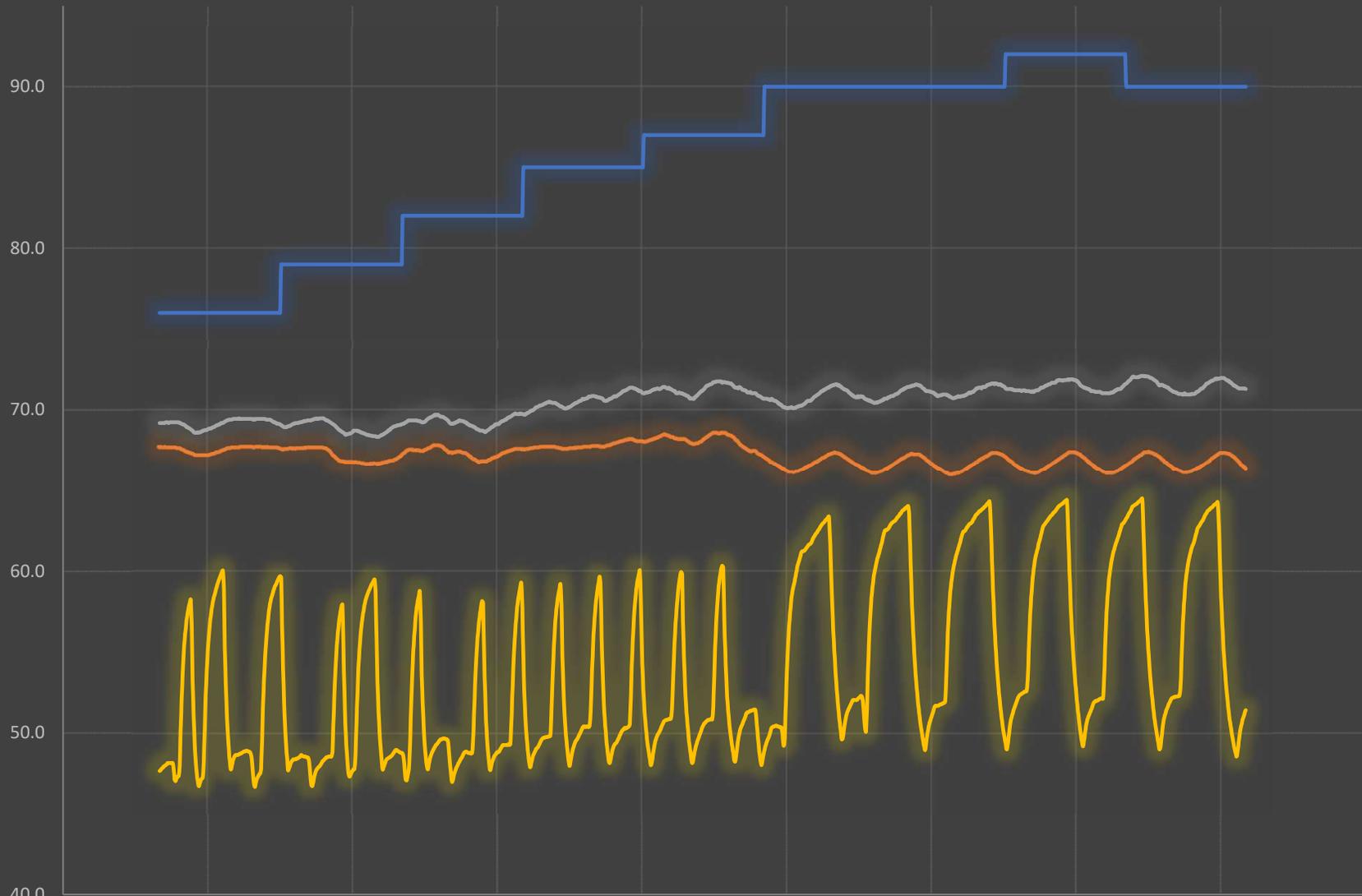
AHU-1 Dry Bulb Over 1-Hour 9/18/2021

OAT Spc T EAT LAT



AHU-2 Space Conditions 1-Hour 9/14/2021

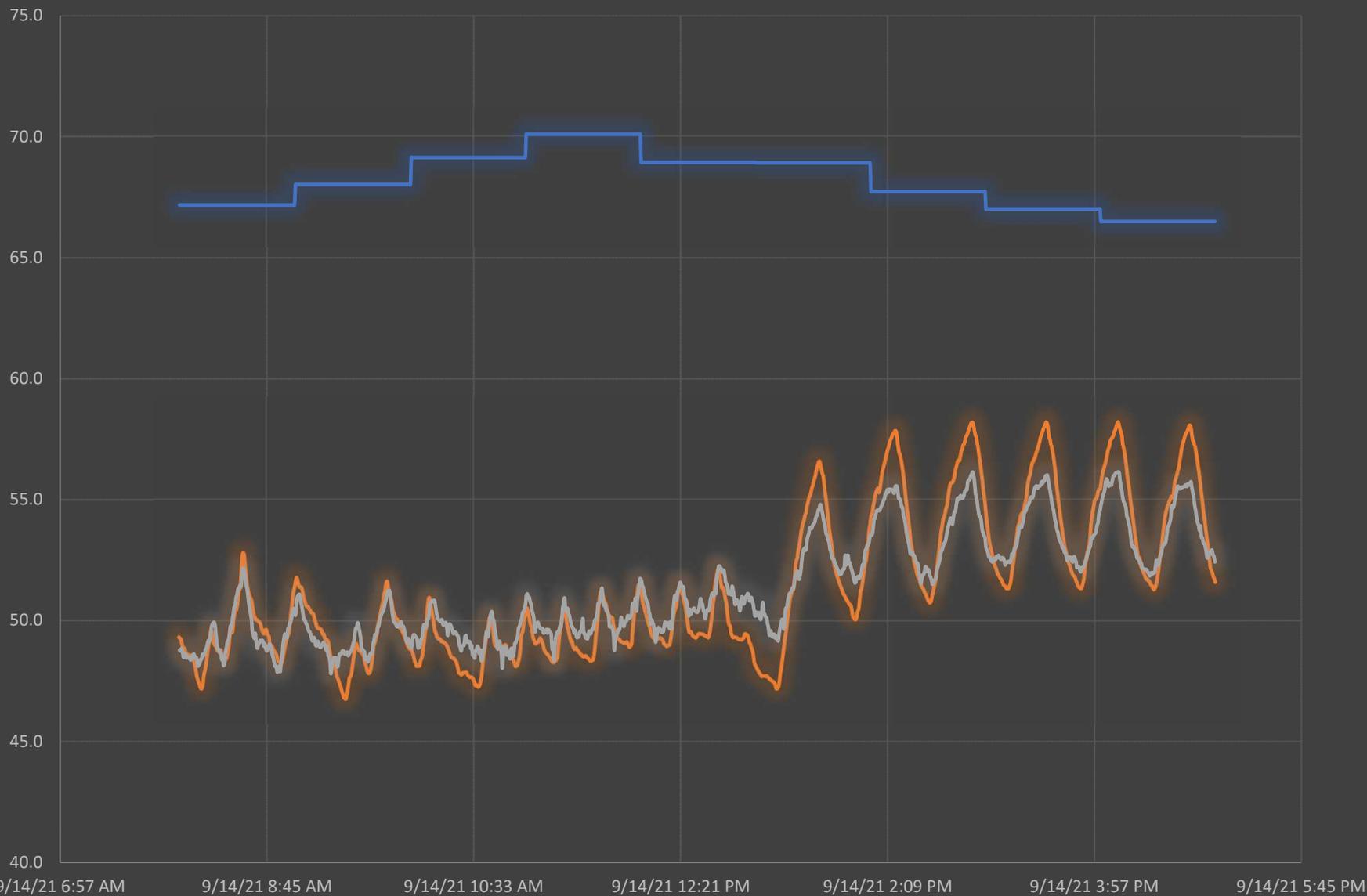
OAT Spc T EAT LAT



9/14/21 7:12 AM 9/14/21 8:24 AM 9/14/21 9:36 AM 9/14/21 10:48 AM 9/14/21 12:00 PM 9/14/21 1:12 PM 9/14/21 2:24 PM 9/14/21 3:36 PM 9/14/21 4:48 PM 9/14/21 6:00 PM

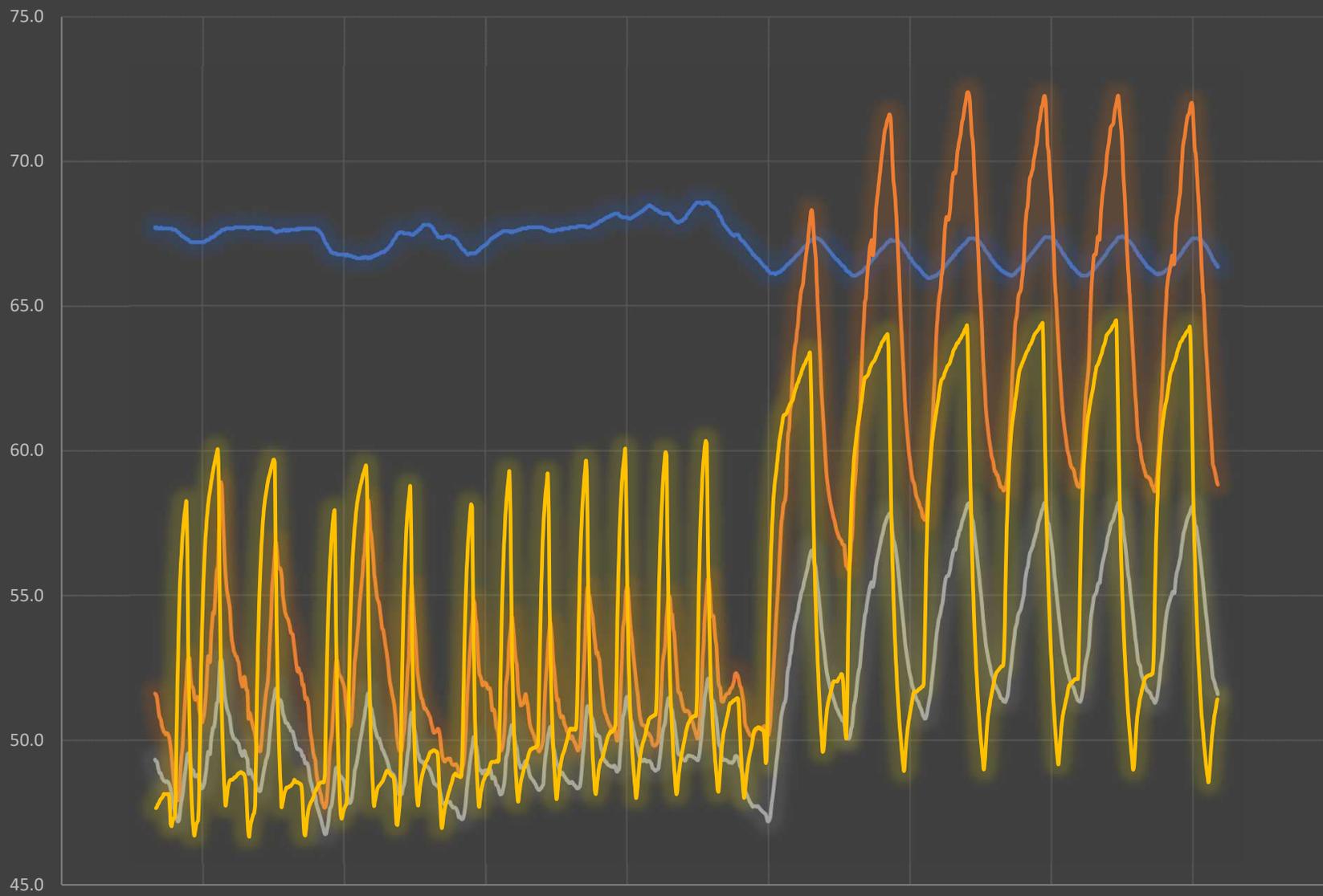
AHU-2 Dew Point Temperature Analysis 9/14/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



AHU-2 Space Conditions 9/14/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



9/14/21 7:12 AM 9/14/21 8:24 AM 9/14/21 9:36 AM 9/14/21 10:48 AM 9/14/21 12:00 PM 9/14/21 1:12 PM 9/14/21 2:24 PM 9/14/21 3:36 PM 9/14/21 4:48 PM 9/14/21 6:00 PM

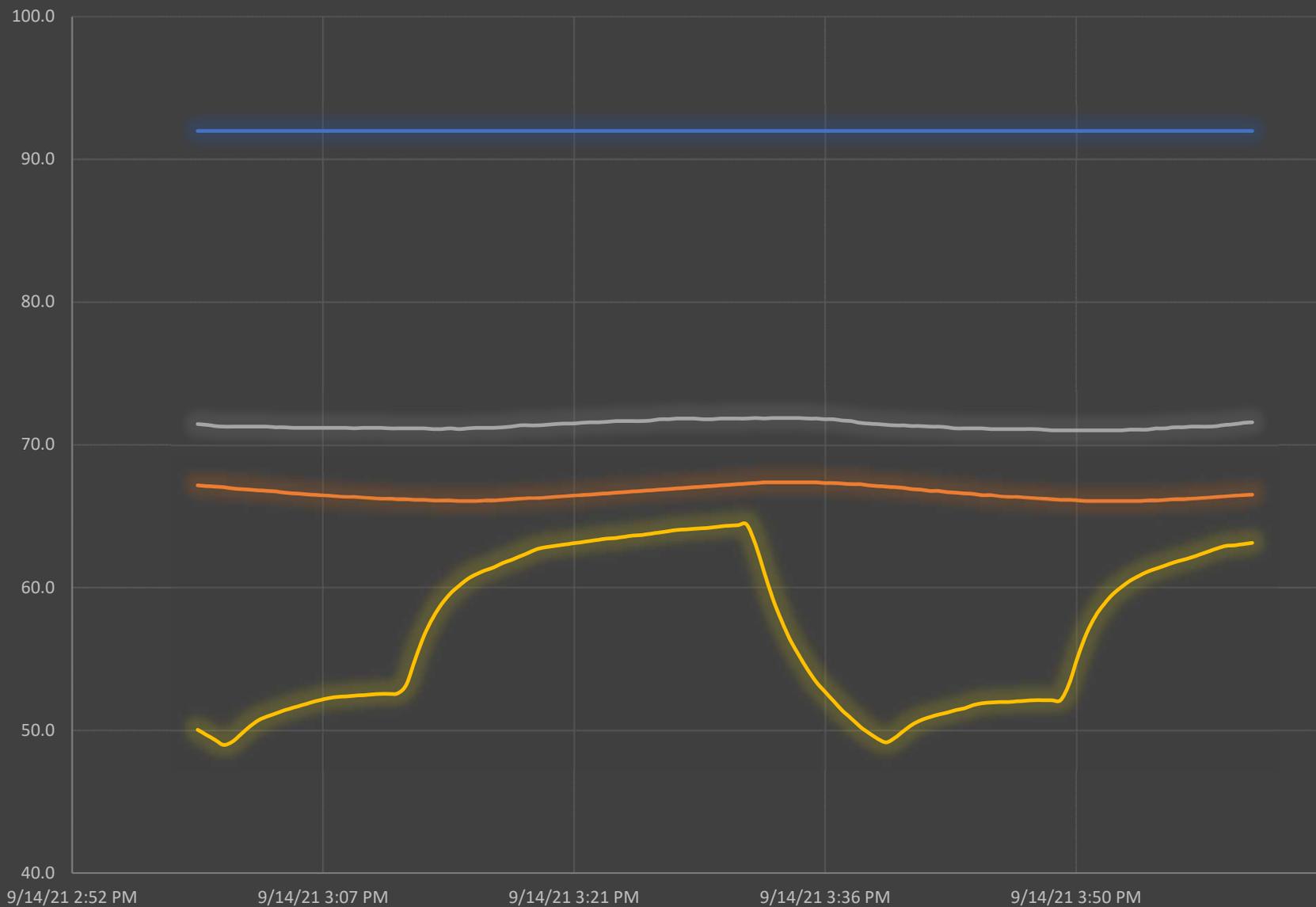
AHU-2 Space Conditions 1-Hour 9/14/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



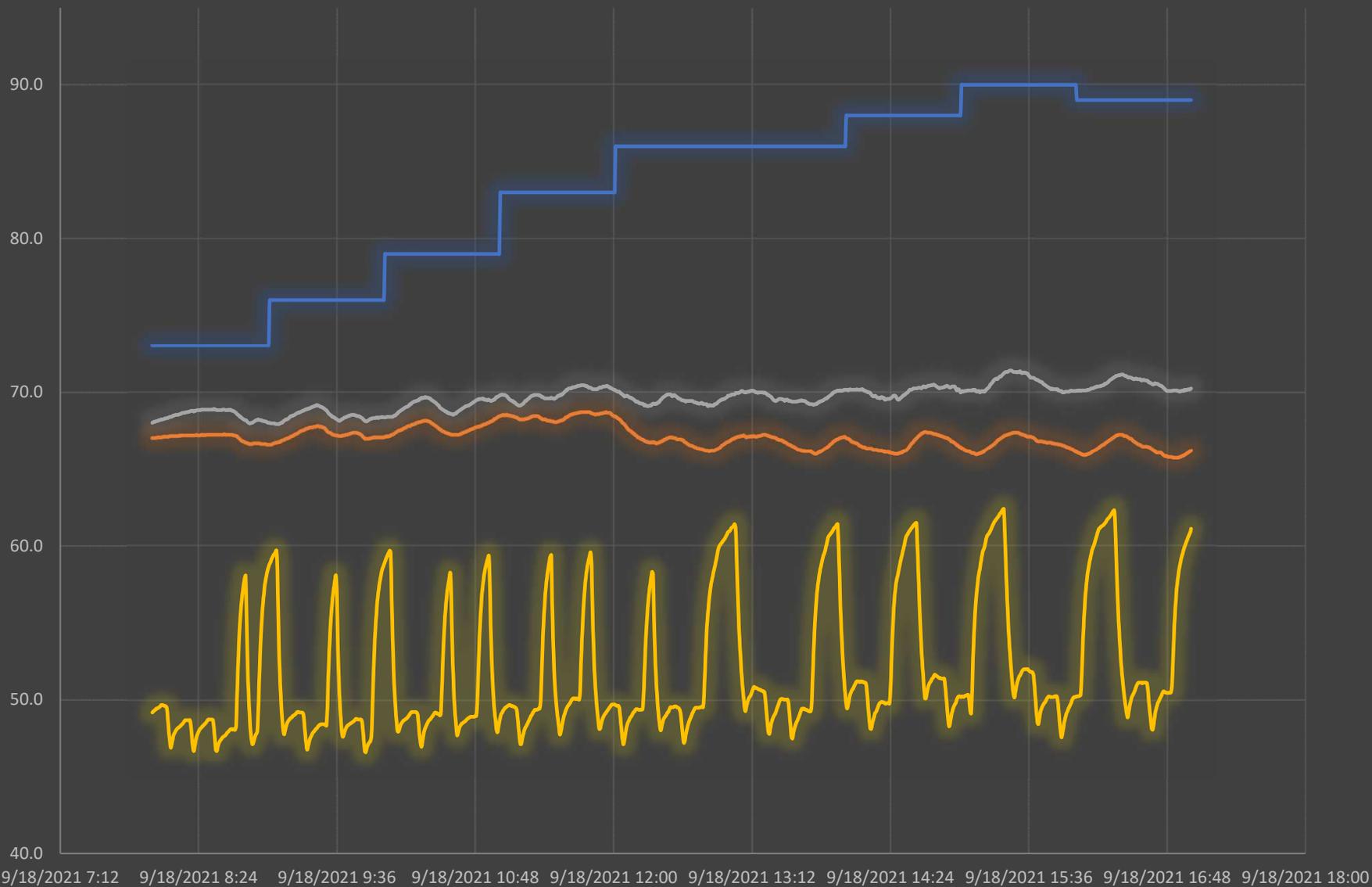
AHU-2 Dry Bulb Over 1-Hour 9/14/2021

OAT Spc T EAT LAT



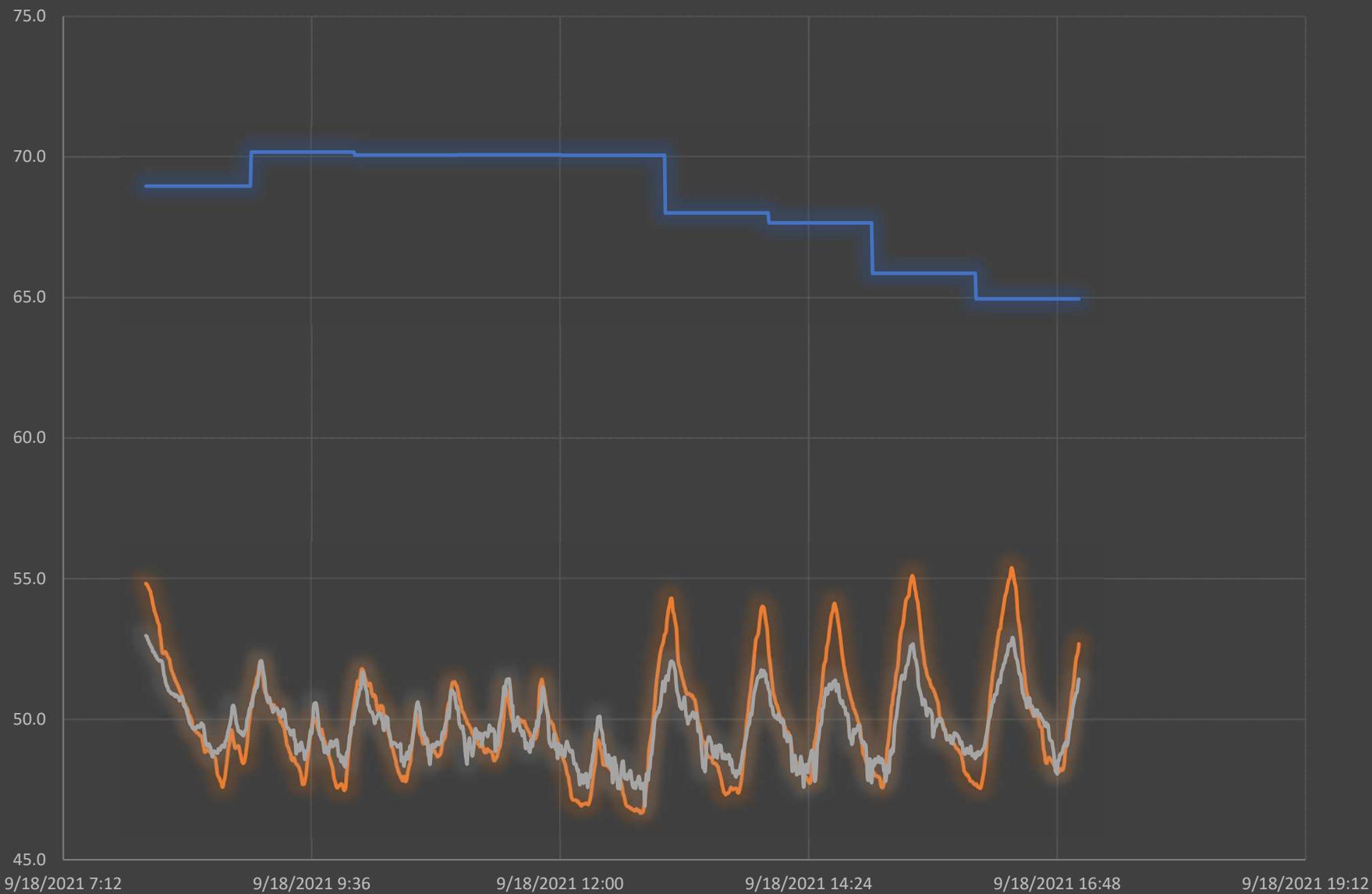
AHU-2 Dry Bulb Temperature Analysis 9/18/2021

OAT Spc T EAT LAT



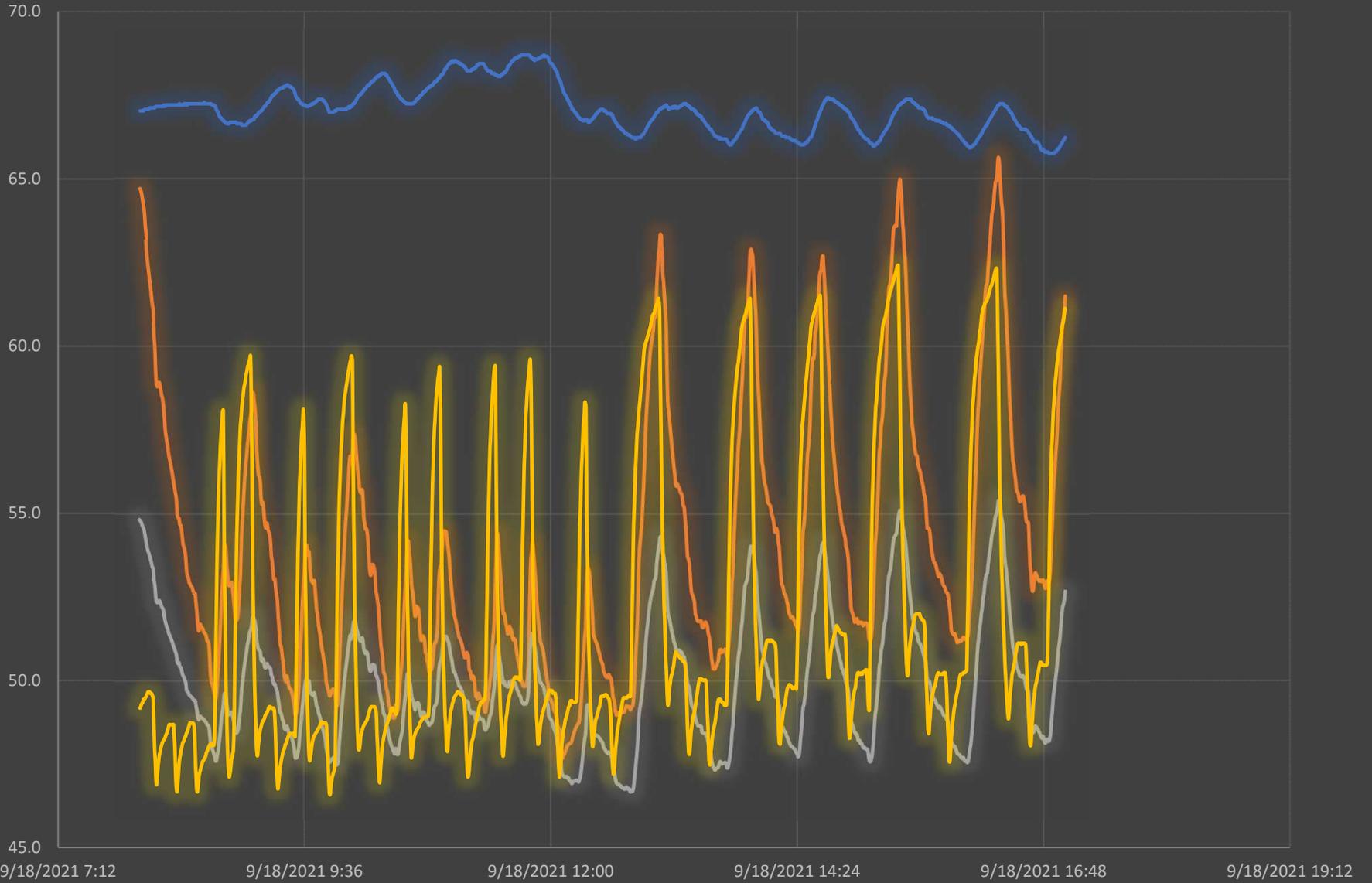
AHU-2 Dew Point Temperature Analysis 9/18/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



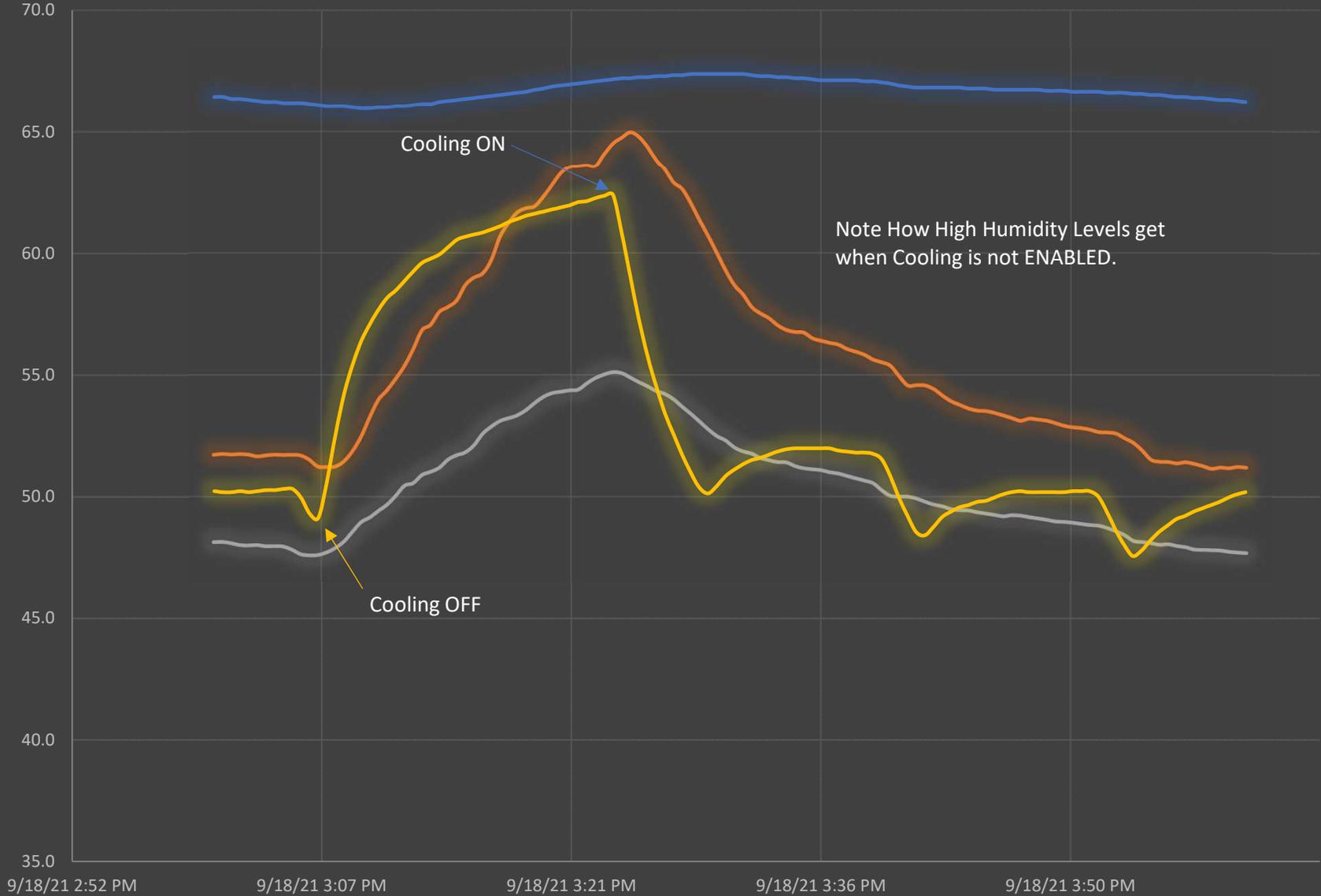
AHU-2 Space Conditions 9/18/2021

Spc T Spc RH Spc Dew Pt LAT



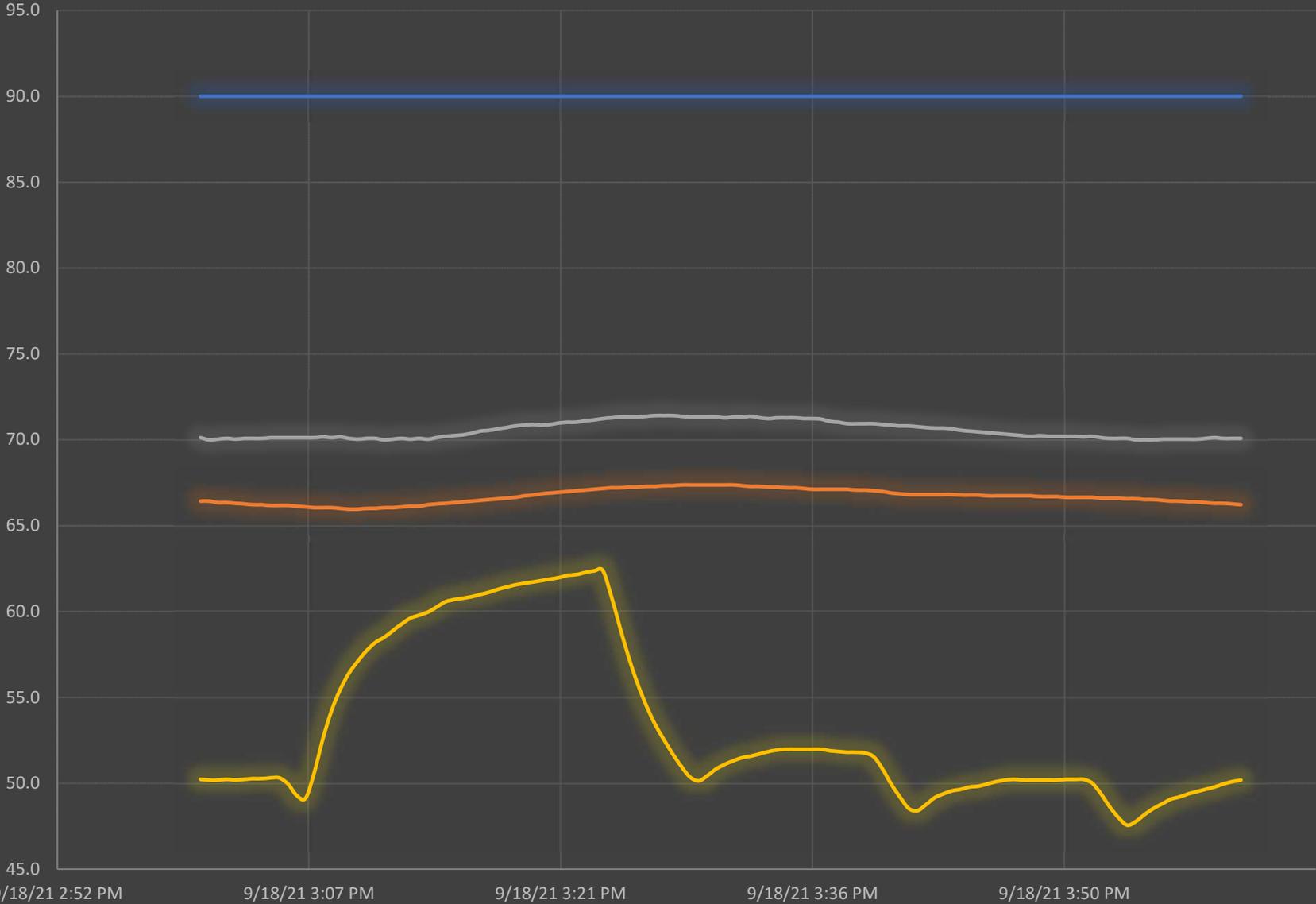
AHU-2 Space Conditions 1-Hour 9/18/2021

Spc T Spc RH Spc Dew Pt LAT



AHU-2 Dry Bulb Over 1-Hour 9/18/2021

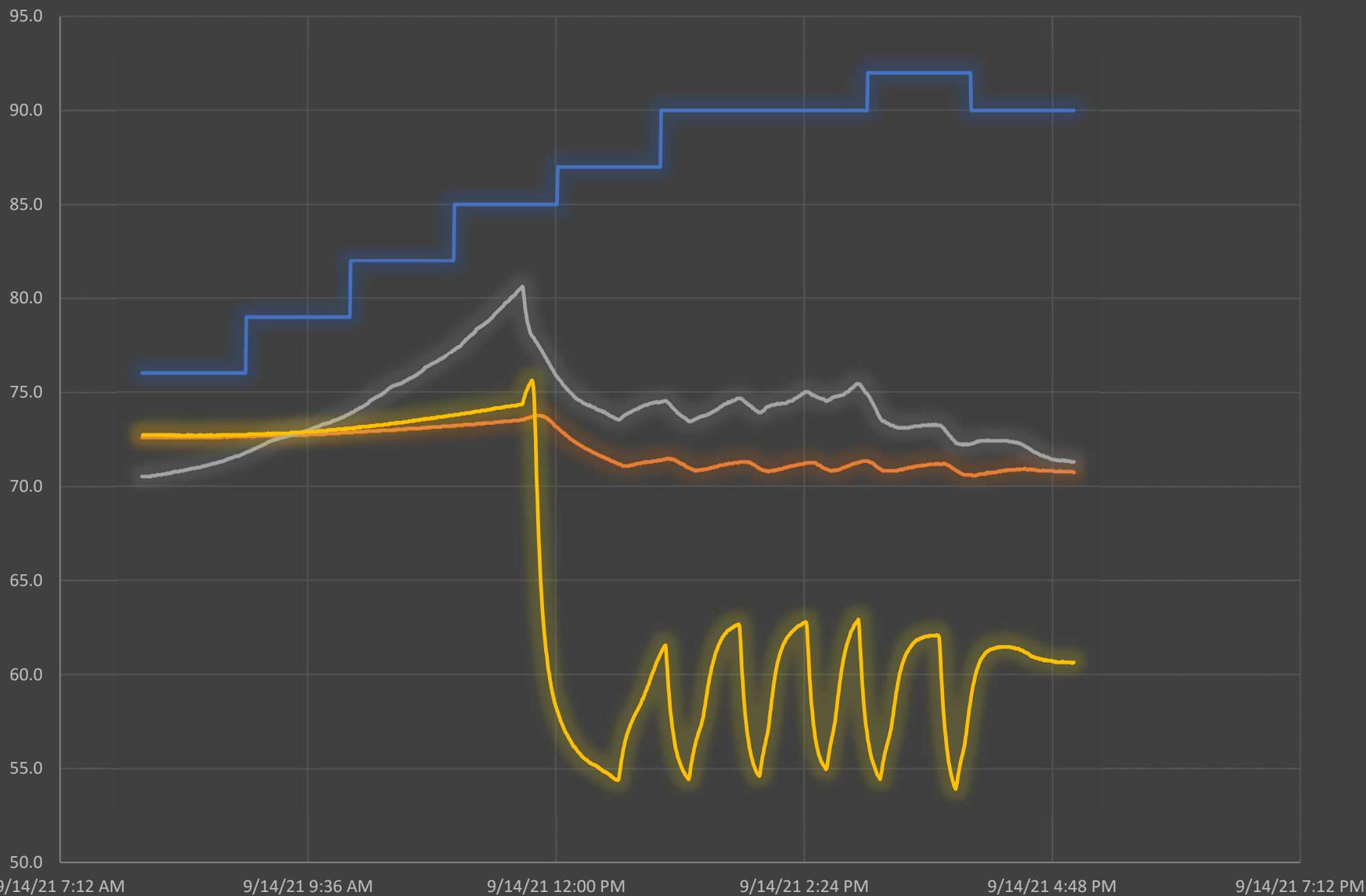
OAT Spc T EAT LAT



APPENDIX E - WRIGHT CITY DATA TABLES & CHARTS

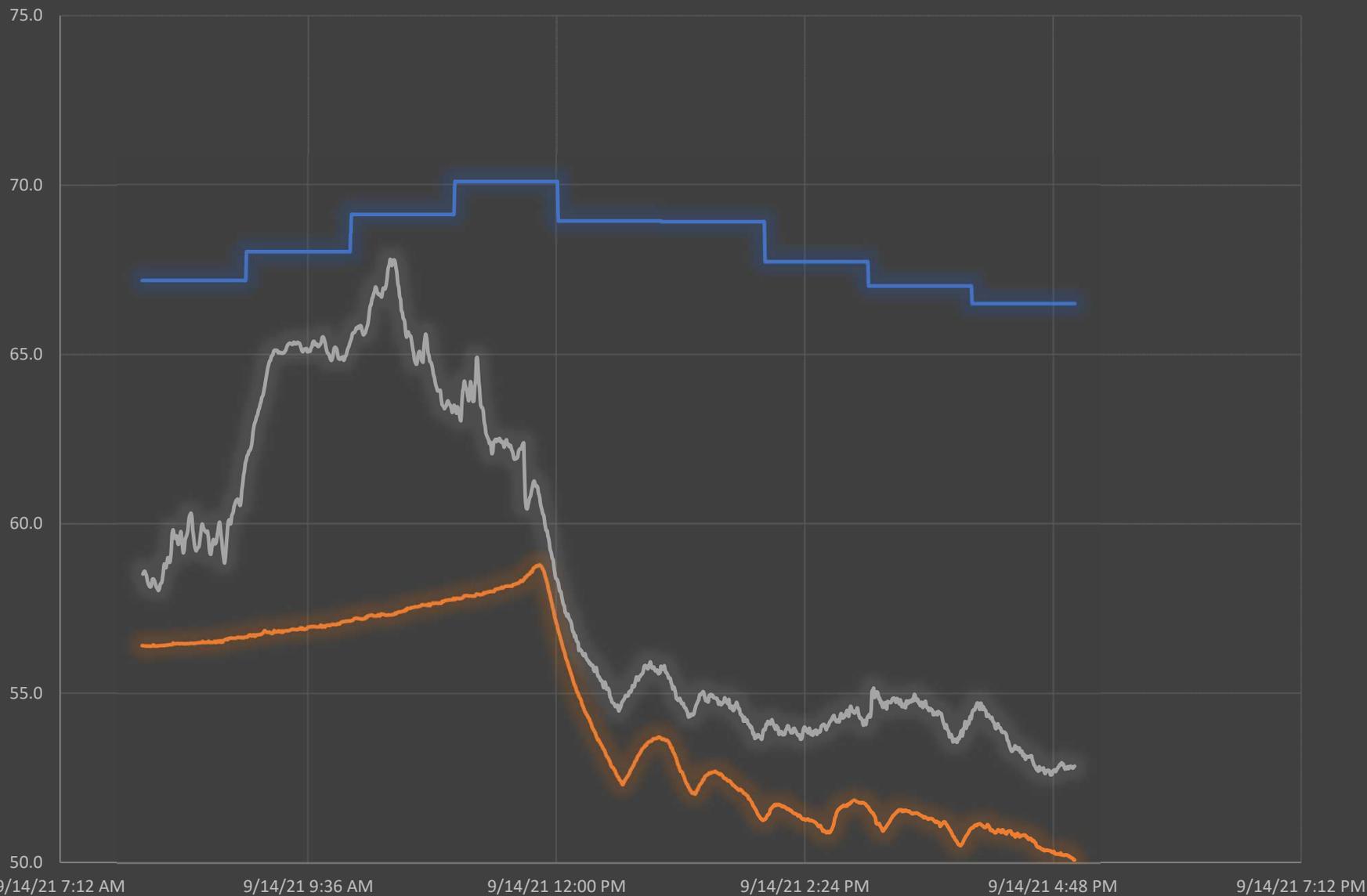
AHU-1 Space Conditions 1-Hour 9/14/2021

OAT Spc T EAT LAT



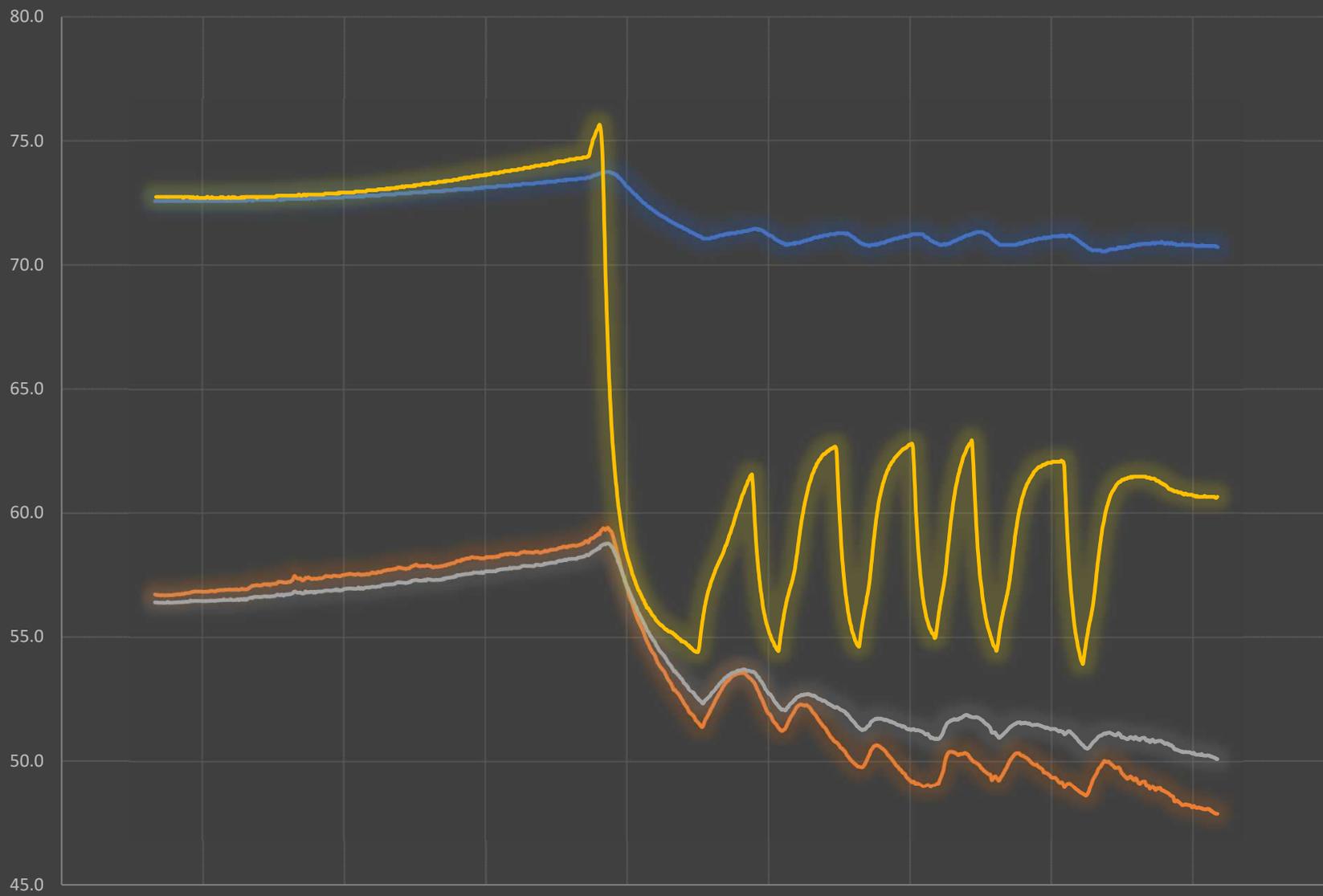
AHU-1 Dew Point Temperature Analysis 9/14/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



AHU-1 Space Conditions 9/14/2021

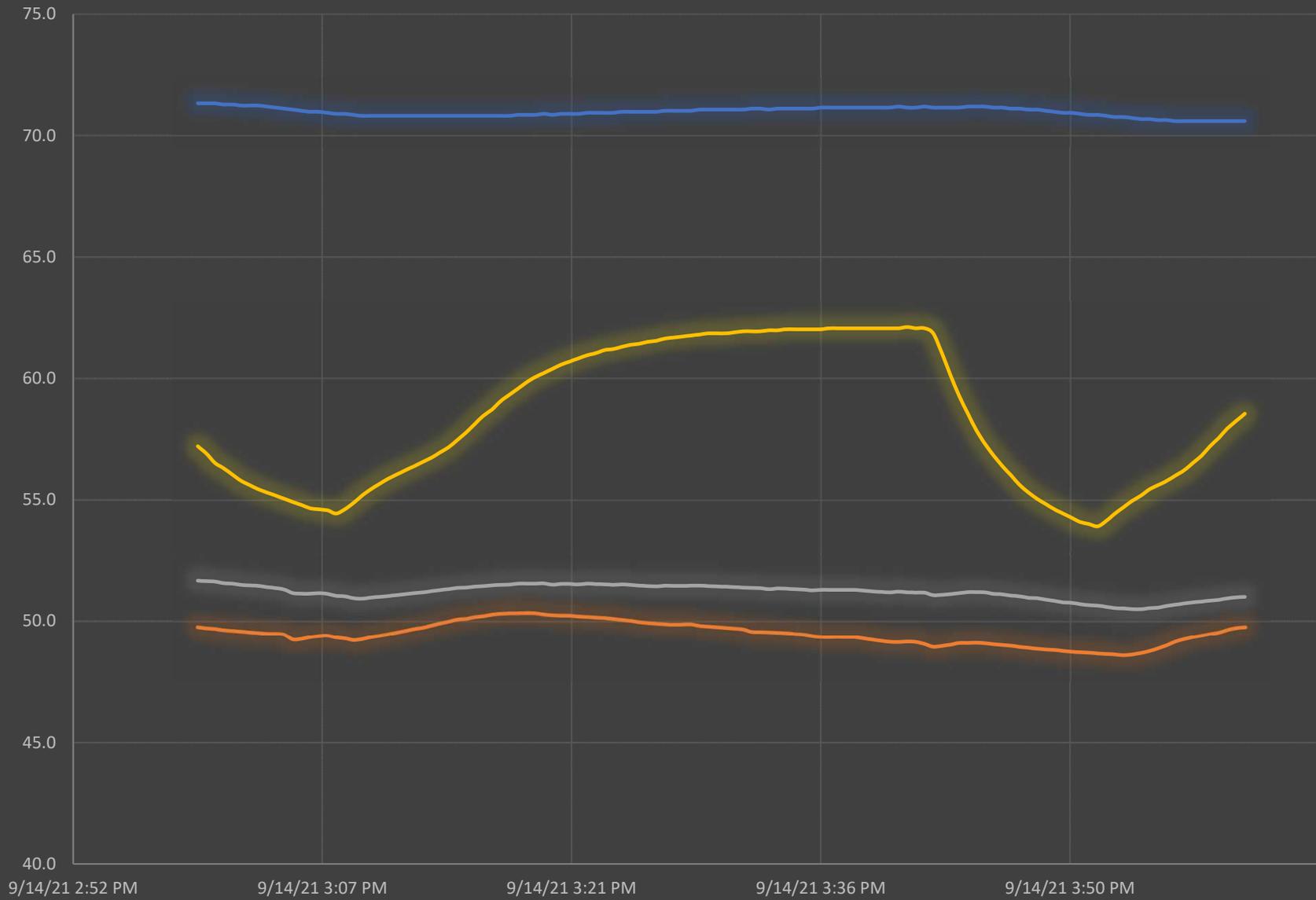
— Spc T — Spc RH — Spc Dew Pt — LAT



9/14/21 7:12 AM 9/14/21 8:24 AM 9/14/21 9:36 AM 9/14/21 10:48 AM 9/14/21 12:00 PM 9/14/21 1:12 PM 9/14/21 2:24 PM 9/14/21 3:36 PM 9/14/21 4:48 PM 9/14/21 6:00 PM

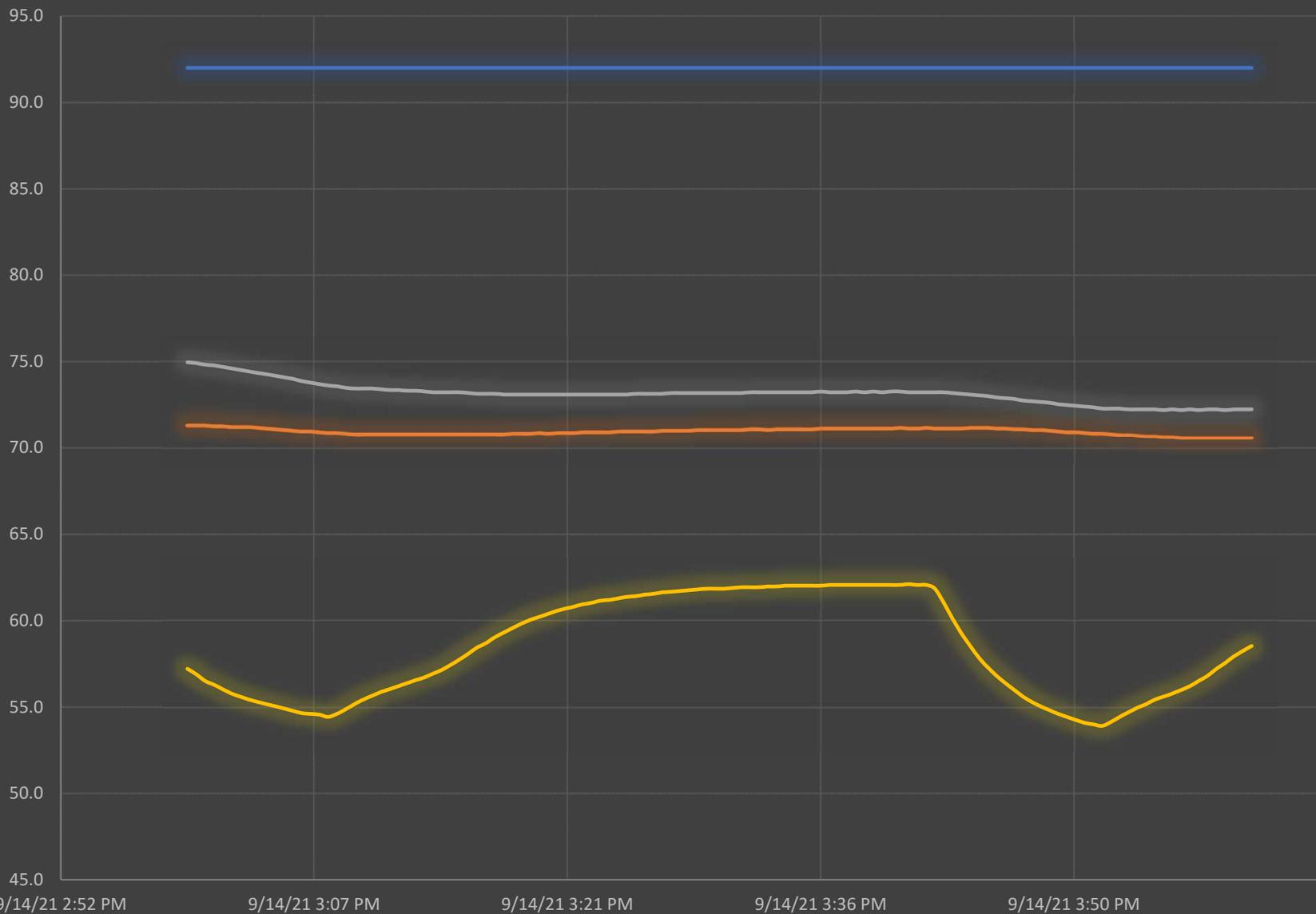
AHU-1 Space Conditions 1-Hour 9/14/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



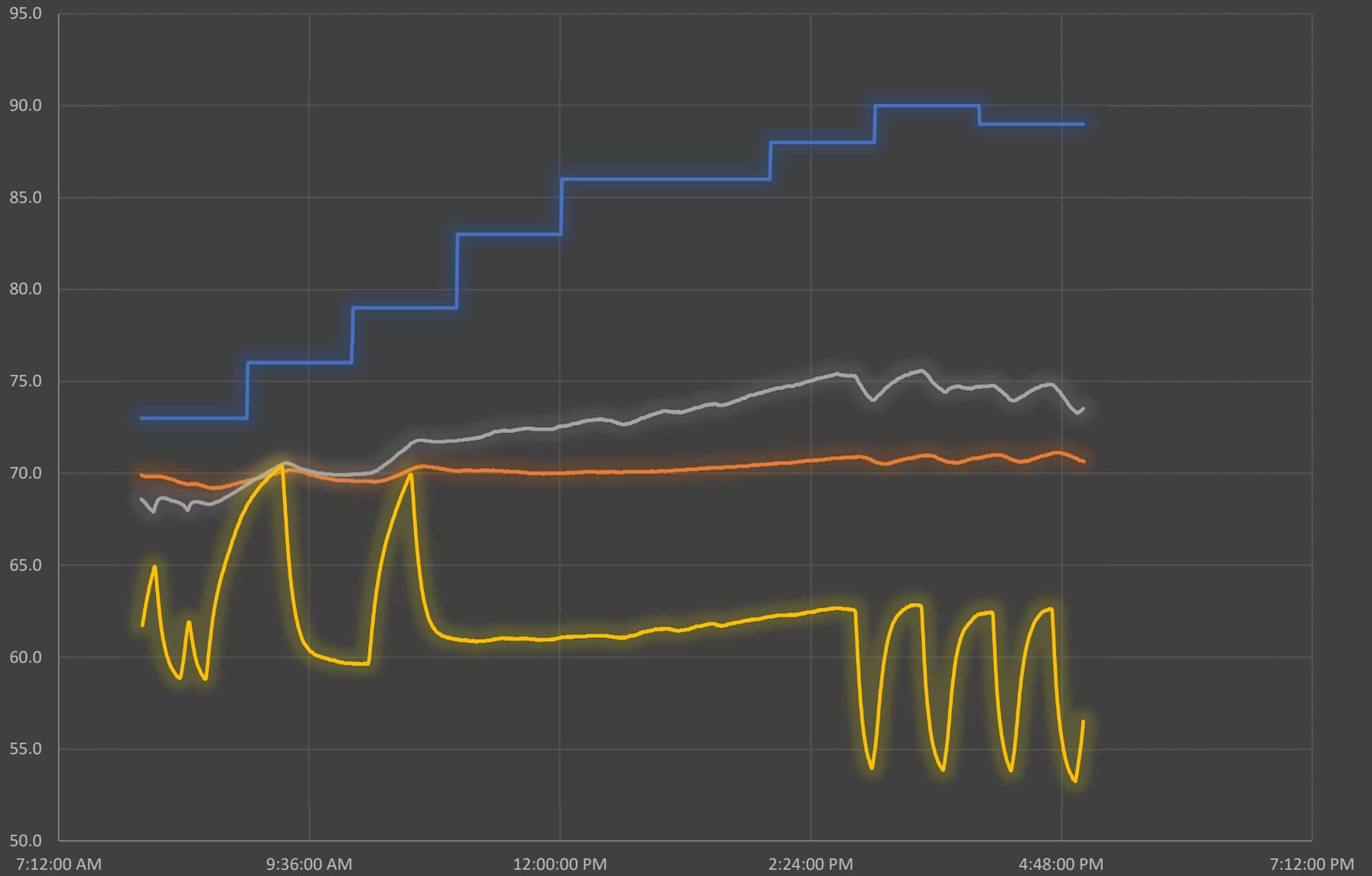
AHU-1 Dry Bulb Over 1-Hour 9/14/2021

OAT Spc T EAT LAT



AHU-1 Dry Bulb Temperature Analysis 9/18/2021

OAT Spc T EAT LAT



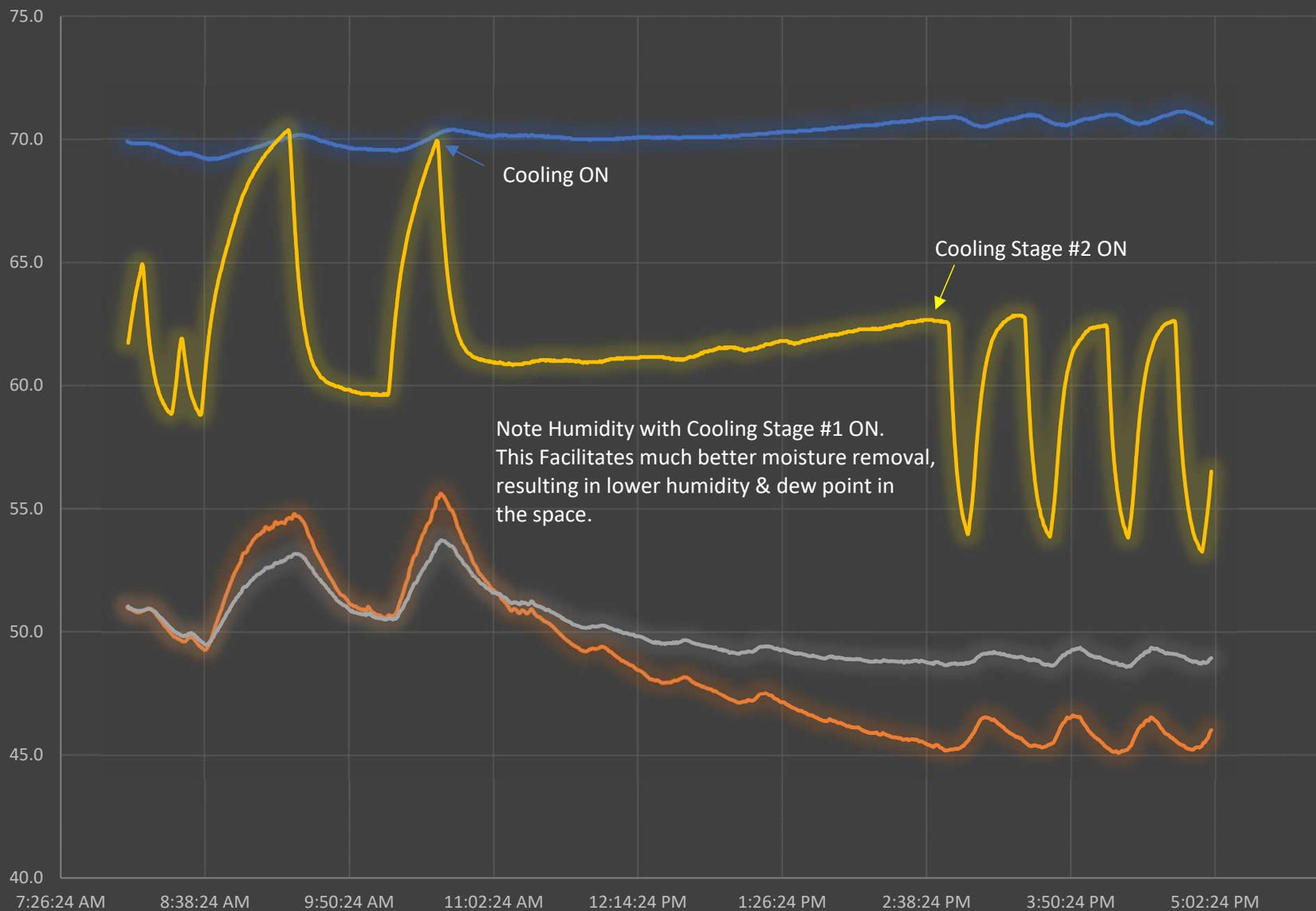
AHU-1 Dew Point Temperature Analysis 9/18/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



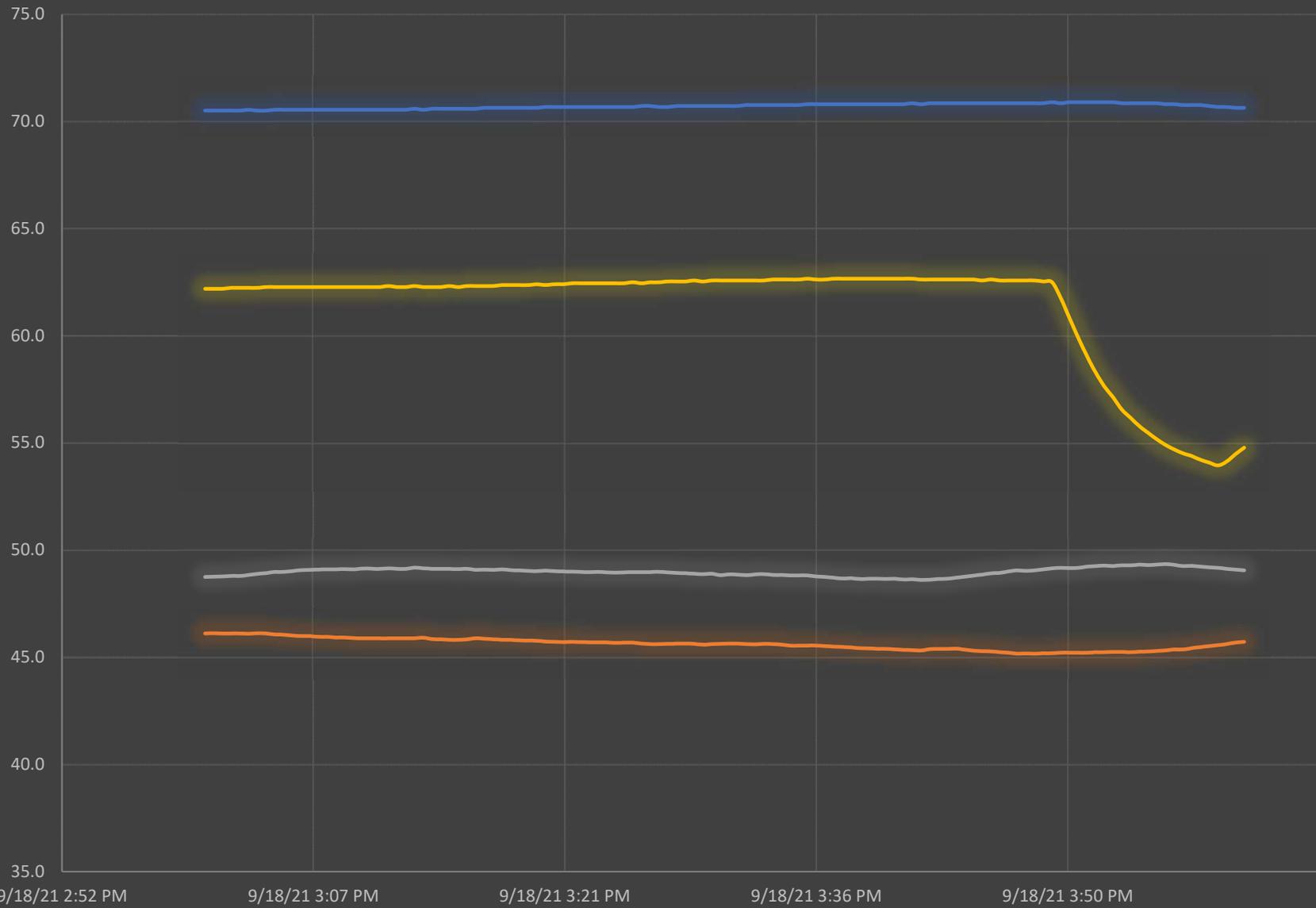
AHU-1 Space Conditions 9/18/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



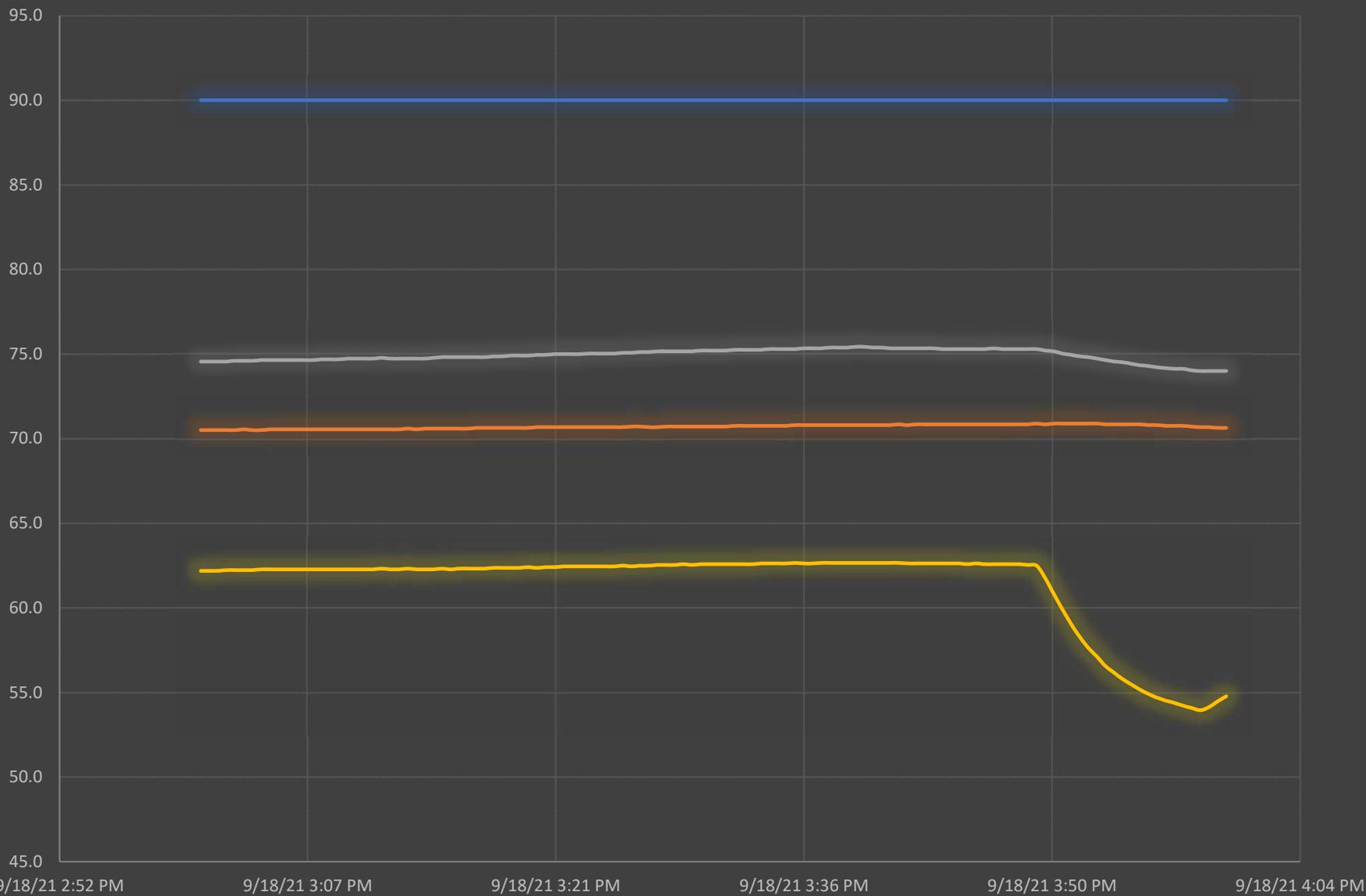
AHU-1 Space Conditions 1-Hour 9/18/2021

Spc T Spc RH Spc Dew Pt LAT



AHU-1 Dry Bulb Over 1-Hour 9/18/2021

OAT Spc T EAT LAT



AHU-2 Data Tables

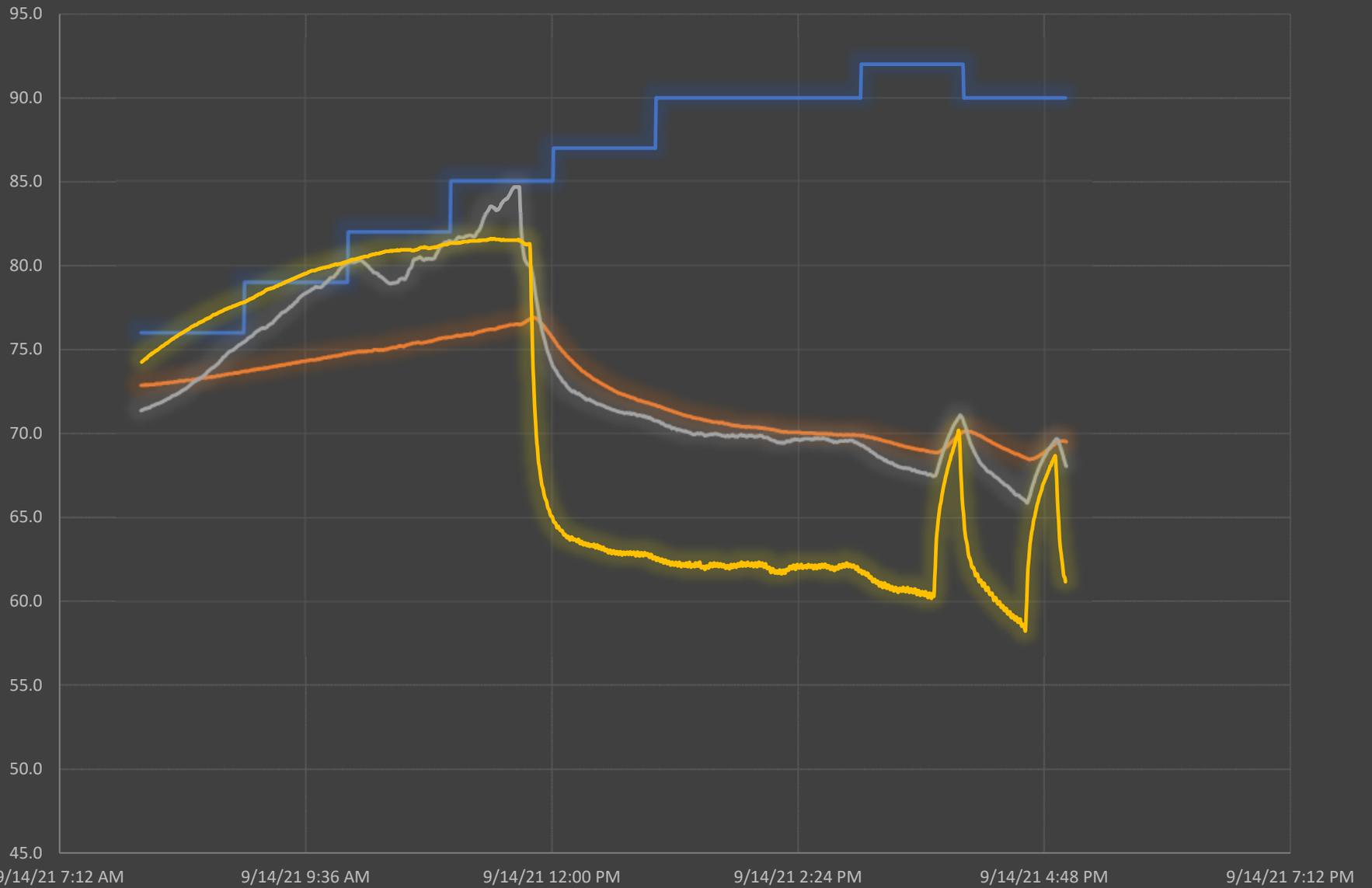
Date Time	OAT	OAH	OA-Enth	OA Dew Pt	RAT	RAH	Spc T	Spc RH	Spc Dew Pt	EAT	EAH	EA-Enth	LAT	LAH	LA-Enth	LA Dew Pt	Coil ΔT	Coil Δh	Spc vs LA Dew Pt
9/14/21 4:55 PM	90.0	46.0	36.9	66.5	69.5	64.4	69.5	64.4	57.1	69.6	62.2	27.2	66.6	58.4	24.8	56.2	3.0	2.4	0.9
9/14/21 4:56 PM	90.0	46.0	36.9	66.5	69.5	64.3	69.5	64.3	57.0	69.5	61.4	27.0	65.6	55.8	23.9	55.8	3.9	3.1	1.3
9/14/21 4:56 PM	90.0	46.0	36.9	66.5	69.6	64.0	69.6	64.0	56.9	69.3	60.7	26.8	64.7	55.7	23.4	55.2	4.7	3.4	1.7
9/14/21 4:57 PM	90.0	46.0	36.9	66.5	69.6	63.7	69.6	63.7	56.8	69.2	60.0	26.6	63.7	56.5	23.0	54.8	5.4	3.5	2.0
9/14/21 4:57 PM	90.0	46.0	36.9	66.5	69.6	63.2	69.6	63.2	56.6	69.0	59.4	26.4	63.1	57.5	22.8	54.4	6.0	3.5	2.2
9/14/21 4:58 PM	90.0	46.0	36.9	66.5	69.6	62.7	69.6	62.7	56.4	68.9	58.9	26.2	62.8	58.5	22.8	54.0	6.1	3.4	2.4
9/14/21 4:58 PM	90.0	46.0	36.9	66.5	69.6	62.3	69.6	62.3	56.2	68.7	58.6	26.1	62.3	59.4	22.7	53.7	6.4	3.4	2.5
9/14/21 4:59 PM	90.0	46.0	36.9	66.5	69.6	61.7	69.6	61.7	55.9	68.5	58.3	25.9	61.9	60.0	22.5	53.3	6.6	3.3	2.6
9/14/21 4:59 PM	90.0	46.0	36.9	66.5	69.6	61.2	69.6	61.2	55.7	68.4	58.0	25.8	61.5	60.5	22.4	53.1	6.9	3.3	2.6
9/14/21 5:00 PM	90.0	46.0	36.9	66.5	69.5	60.8	69.5	60.8	55.4	68.1	57.7	25.6	61.4	60.9	22.4	52.7	6.7	3.2	2.7
9/14/21 5:00 PM	90.0	46.0	36.9	66.5	69.5	60.3	69.5	60.3	55.2	68.1	57.4	25.5	61.2	61.3	22.3	52.5	6.9	3.2	2.7

AHU-2 Data Tables

Date Time	OAT	OAH	OA-Enth	OA Dew Pt	RAT	RAH	Spc T	Spc RH	Spc Dew Pt	EAT	EAH	EA-Enth	LAT	LAH	LA-Enth	LA Dew Pt	Coil ΔT	Coil Δh	Spc vs LA Dew Pt
9/18/2021 16:55	89.0	45.0	35.9	65.0	71.8	60.0	71.8	60.0	57.3	72.1	59.8	28.3	68.9	81.9	30.1	57.5	3.2	-1.7	-0.2
9/18/2021 16:56	89.0	45.0	35.9	65.0	71.9	60.5	71.9	60.5	57.6	72.3	59.8	28.4	69.1	81.0	30.1	57.6	3.1	-1.7	0.0
9/18/2021 16:56	89.0	45.0	35.9	65.0	71.9	61.1	71.9	61.1	57.8	72.4	59.9	28.5	69.3	80.1	30.1	57.7	3.0	-1.6	0.1
9/18/2021 16:57	89.0	45.0	35.9	65.0	71.9	61.6	71.9	61.6	58.1	72.4	59.9	28.5	69.6	79.3	30.2	57.8	2.8	-1.6	0.3
9/18/2021 16:57	89.0	45.0	35.9	65.0	72.0	61.9	72.0	61.9	58.3	72.6	60.1	28.6	69.9	78.5	30.2	58.0	2.6	-1.6	0.3
9/18/2021 16:58	89.0	45.0	35.9	65.0	72.0	62.2	72.0	62.2	58.4	72.7	60.1	28.7	70.3	77.5	30.3	58.1	2.4	-1.6	0.3
9/18/2021 16:58	89.0	45.0	35.9	65.0	72.0	62.4	72.0	62.4	58.5	72.7	60.2	28.8	70.6	76.5	30.3	58.2	2.2	-1.6	0.3
9/18/2021 16:59	89.0	45.0	35.9	65.0	72.1	62.7	72.1	62.7	58.7	72.9	60.2	28.8	70.9	75.5	30.4	58.3	1.9	-1.5	0.4
9/18/2021 16:59	89.0	45.0	35.9	65.0	72.1	63.1	72.1	63.1	58.9	73.0	60.1	28.9	71.2	74.4	30.4	58.4	1.7	-1.5	0.5
9/18/2021 17:00	89.0	45.0	35.9	65.0	72.1	63.4	72.1	63.4	59.1	73.1	60.1	29.0	71.6	73.5	30.5	58.5	1.5	-1.5	0.6
9/18/2021 17:00	89.0	45.0	35.9	65.0	72.2	63.7	72.2	63.7	59.3	73.2	60.2	29.1	71.9	72.7	30.5	58.7	1.3	-1.5	0.6

AHU-2 Space Conditions 1-Hour 9/14/2021

OAT Spc T EAT LAT



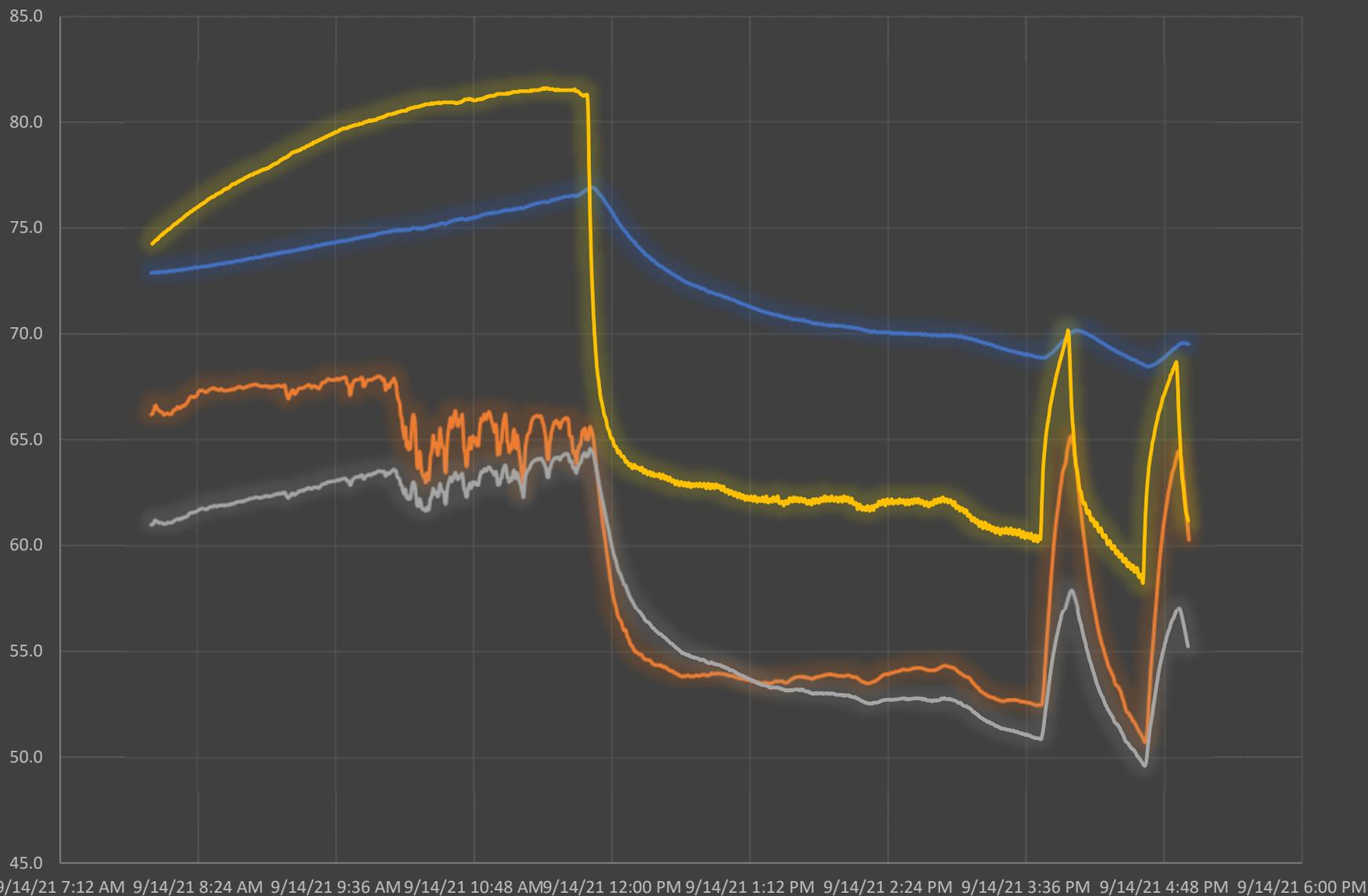
AHU-2 Dew Point Temperature Analysis 9/14/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



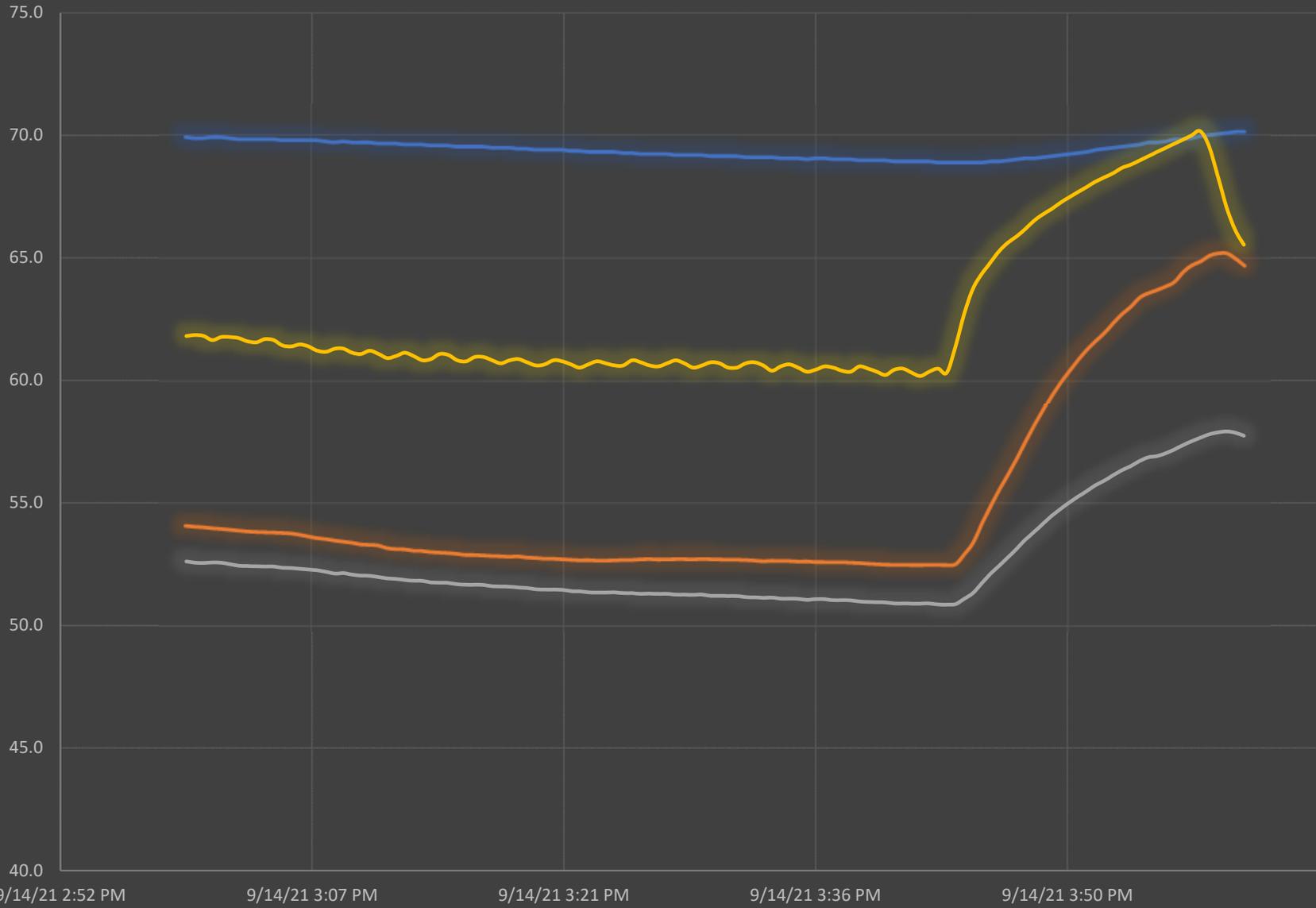
AHU-2 Space Conditions 9/14/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



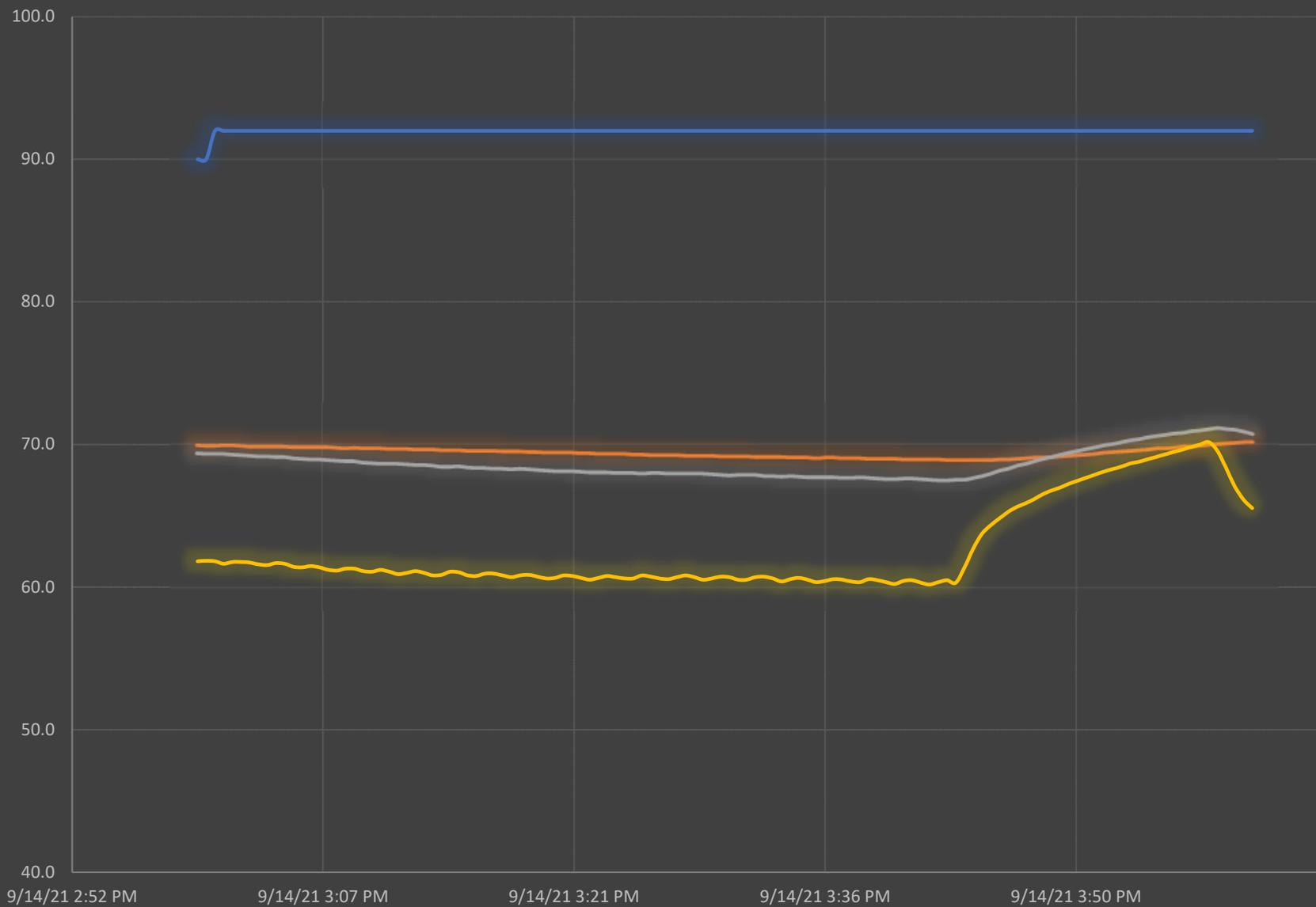
AHU-2 Space Conditions 1-Hour 9/14/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



AHU-2 Dry Bulb Over 1-Hour 9/14/2021

OAT Spc T EAT LAT



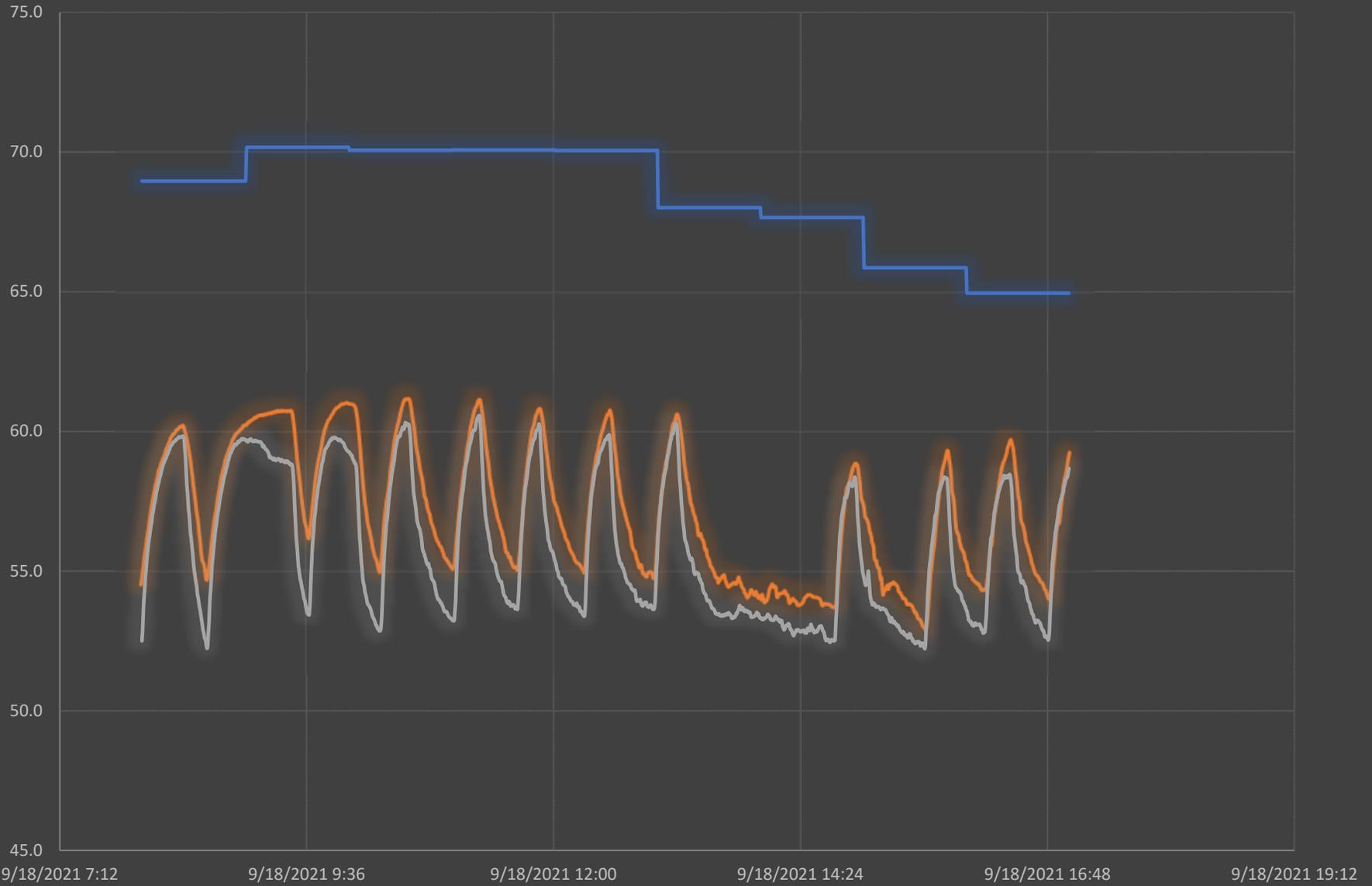
AHU-2 Dry Bulb Temperature Analysis 9/18/2021

OAT Spc T EAT LAT



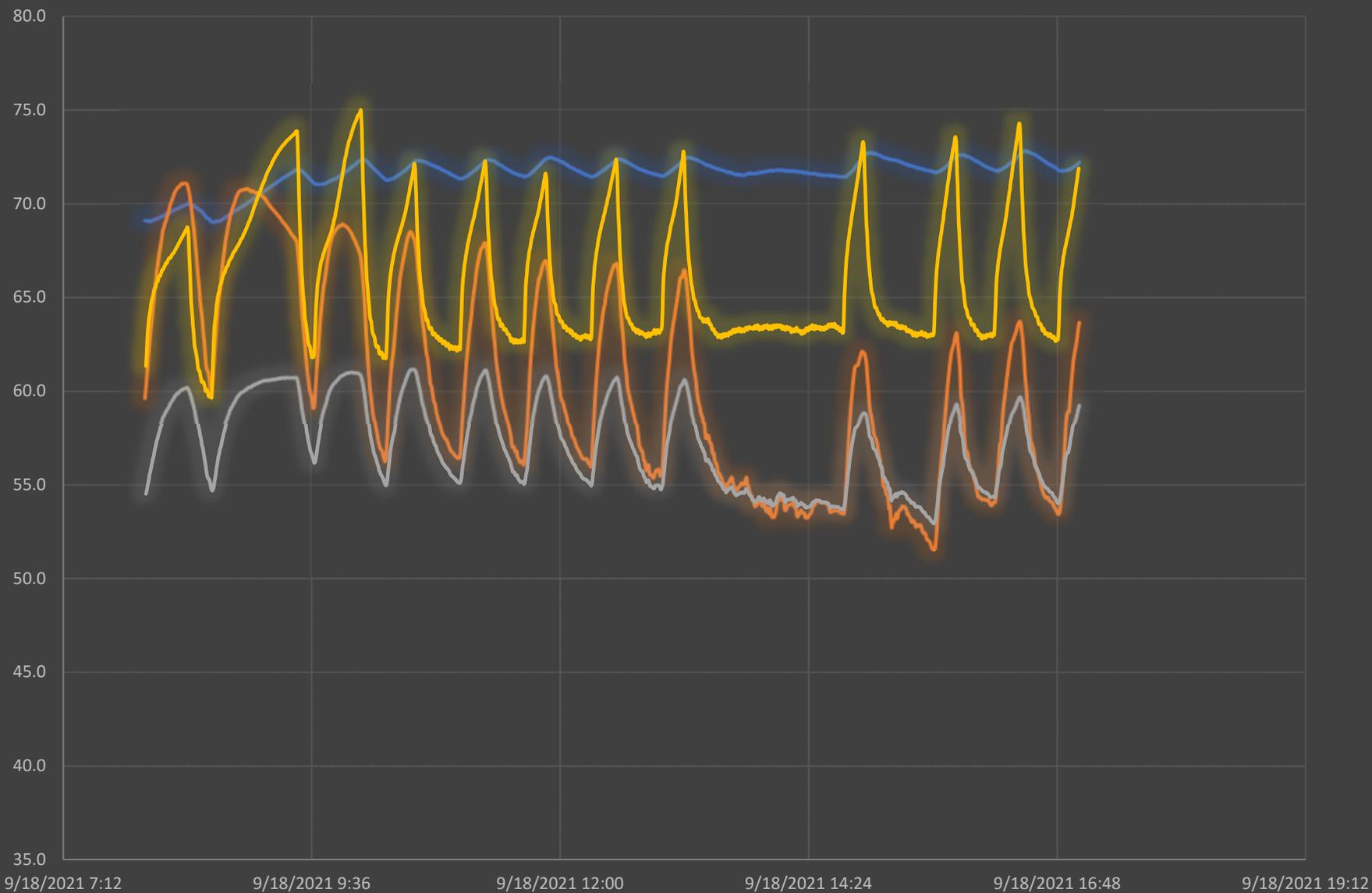
AHU-2 Dew Point Temperature Analysis 9/18/2021

— OA Dew Pt — Spc Dew Pt — LA Dew Pt



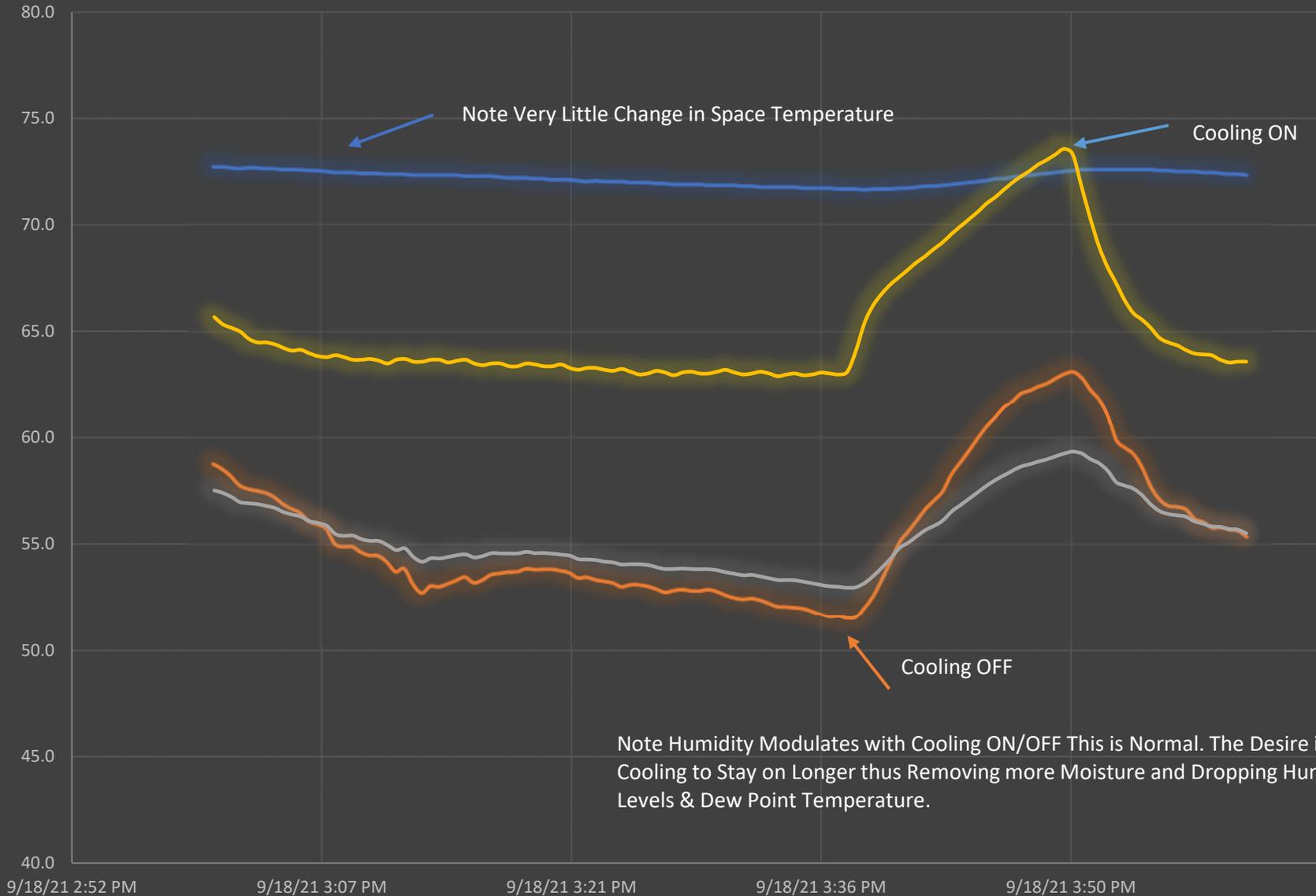
AHU-2 Space Conditions 9/18/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



AHU-2 Space Conditions 1-Hour 9/18/2021

— Spc T — Spc RH — Spc Dew Pt — LAT



Note Humidity Modulates with Cooling ON/OFF This is Normal. The Desire is for Cooling to Stay on Longer thus Removing more Moisture and Dropping Humidity Levels & Dew Point Temperature.

AHU-2 Dry Bulb Over 1-Hour 9/18/2021

OAT Spc T EAT LAT

