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EASTERN WASHINGTON UNIVERSITY
JFK LIBRARY
HVAC PERFORMANCE REVIEW
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EASTERN WASHINGTON UNIVERSITY JFK LIBRARY
KJH ENGINEERING HVAC PERFORMANCE INVESTIGATION

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PART 1 EXECUTIVE SUMMARY

KJH Engineering was contacted by EWU Construction and Planning Services in May of 2018 and asked to furnish a proposal to review the performance of the JFK HVAC system related to recent complaints of poor indoor air quality. EWU had recently performed a HVAC controls upgrade and wanted a third party professional investigation of the performance of the HVAC systems that serve the offices and book stacks areas of the library. The scope of work was agreed to be onsite investigation of air handling units (AHU) 1 thru 7 outside air ventilation quantities and the carbon dioxide (CO₂) demand control ventilation system performance. Also, the scope of work included a sample of testing (20) terminal/mixing boxes that serve the occupied spaces to measure the amounts of air being delivered as well as the controls sequencing of the air flows. The minimum and maximum amounts of outside air were measured by two methods: one method using the existing air flow monitoring station (AFMS) and the second by pitot tube traverse of the outside air ducts. A subsequent correction factor for the AFMS is included. Below is a listing of the results of these measurements and tests.

PART 2 HVAC PERFORMANCE INVESTIGATION

2.01 AHU-1 THRU 7

A. OUTSIDE AIR FLOW MEASUREMENTS

These air handling units are of the dual duct mixing box type, warm air and cool air travel through separate ducts and are mixed at the terminal unit mixing box and introduced to the space to maintain the desired room temperature. Each AHU has a dedicated supply fan for the cold duct and warm duct with a common shared return fan. Outside air is introduced to the cold duct supply fan and is used when appropriate for a source of cooling. The outside air is also used to provide a healthy occupied space environment and subsequent indoor air quality. Introducing outside air involves a higher operating cost due to the required conditioning of this air stream. CO₂ concentration levels are used in the HVAC industry as a gage of

building occupancy. The JFK HVAC control system measures the CO₂ concentration levels contained in the return air stream as a method of controlling the amount of outside air required for indoor air quality. If the CO₂ concentration is equal to or less than a predetermined amount, then the quantity of outside air is maintained at a minimum. As the CO₂ concentration increases from its minimum towards the maximum, the amount of outside air introduced is increased proportionately until the cold deck fan is providing 100% outside air and no return air. At any one time, the amounts of return air and outside air being mixed at the AHU are indirectly proportional, meaning as one quantity increases, the other decreases. KJH measured the amounts of outside air being introduced by each of the (7) AHU's at the minimum and maximum delivery levels. KJH also verified the demand control ventilation sequencing of the outside air damper based on return air CO₂ concentrations. The results of the measurements of quantities of outside air and status of the demand control ventilation controls are listed in the table below.

AIR HANDLING UNIT	MINIMUM OUTSIDE AIR (CFM)	MAXIMUM OUTSIDE AIR (CFM)	DEMAND CONTROL VENTILATION SEQUENCING	CORRECTION FACTOR (AT MAXIMUM)
AHU-1	2,205	10,010	CORRECT	1.2
AHU-2	1,615	7,820	CORRECT	0.915
AHU-3	2,405	11,185	CORRECT	0.85
AHU-4	2,080	9,065	CORRECT	0.8
AHU-5	2,040	8,530	CORRECT	0.84
AHU-6	1,915	9,780	CORRECT	0.95
AHU-7	1,154	5,770	CORRECT	0.81
Deficiencies: None				

B. DEMAND CONTROL VENTILATION FUNCTIONALITY

The functionality of Air Handling Units 1 thru 7 is correct and performed as described above. The test was accomplished by overriding the CO₂ set-points and physically observing the positioning of the outside air dampers.

2.02. TERMINAL/MIXING BOX

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A sample of (20) terminal mixing boxes were tested for air flow quantities and controls performance/sequencing of the box dampers (hot duct and cold duct). The outdoor air/ventilation to the occupied space is maintained by the constant introduction of a minimum amount of cold duct air flow. This minimum amount of ventilation is maintained throughout the heating mode as shown by the sum of the cold duct and hot duct air flows. Design CFM's are shown from the original project documents dated 1995.

A. AIR FLOW QUANTITIES

Box Number	ROOM	DESIGN MAX COOLING (CFM)	DESIGN MINIMUM COOLING (CFM)	DESIGN HEATING (CFM), MIN COOLING + HEATING	ACTUAL MAX COOLING (CFM)	ACTUAL MINIMUM COOLING (CFM)	ACTUAL HEATING (CFM)
1.7	L-23	960	480	960	980	450	1025
1.11	M-28	110	50	110	110	125	245
1.13	M-24	500	120	500	505	180	505
1.23	M-45	1000	330	1000	1105	445	1025
3.1	U-34	320	160	320	350	280	360
3.3	U-35	1250	350	1250	1480	670	1400
5.14	M-01	750	200	750	800	275	865
5.24	M-17	500	180	500	500	145	545
6.23	U-04	600	180	600	945	310	945
6.25	U-12B	800	440	800	1235	775	1150
6.26	U-12A	525	150	450	905	360	735
6.29	U-02A	200	100	200	200	140	195
6.30	U-02A	550	300 *	690 *	680	555	1010
6.31	U-06	450	250	550 *	760	485	800
6.32	U-02B	350	150	500 *	435	330	490
6.33	U-02C	400	150	500 *	385	165	545
6.34	U-18	1320	400	1280	1645	775	1460
7.21	U-31	125	30	125	155	50	150
7.22	U-29	125	30	125	160	60	155
7.23	U-27	125	30	125	150	65	110
<p>NOTES: ALL TERMINAL BOX CONTROL SEQUENCING OPERATED AS DESIGNED, PROPERLY CYCLING THE AIR FLOW STREAMS (HOT & COLD) FROM HEATING TO MINIMUM TO COOLING ON DEMAND</p> <p>* INDICATES VALUES HAVE BEEN ENTERED THAT ARE HIGHER THAN ORIGINAL DESIGN.</p> <p>INDICATES ACTUAL AIR FLOW RATE IS HIGHER THAN DESIGN BY AT LEAST 10%</p>							

B. CONTROLS FUNCTIONALITY

Each terminal/mixing box investigated, was ran through a functional performance test to determine if correct sequencing of air flows based upon temperature demand and proper ventilation was being provided. This test consisted of overriding the temperature set-point to initiate a call for: heating, minimum cooling and maximum cooling and observing and measuring the sequencing and actual airflows while transitioning from mode to mode as well as within each mode. All terminal/mixing boxes operated as intended.

PART 3 LIST OF DEFICIENCIES

NONE:

PART 4 CONCLUSION

The measurements and functional performance tests shown above indicate that the HVAC systems listed are performing as intended. It is of my professional opinion that the controls sequencing of the air handling unit's ventilation based upon CO2 concentration is correct. Also, the sample of mixing boxes tested indicate proper controls sequencing based upon temperature demand and the air flow rates are meeting design requirements. All air flow measurements and functional performance testing was performed by Kelly J. Harkins

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