



## **5. Breadth Analysis 1 – Centralized HVAC for Office Spaces**

### *Problem Statement*

The current mechanical system for Two Liberty Center has an individual air handling unit for each office floor, as well as several units to serve retail spaces and common areas. Multiple air handling units adds significant complication to the construction process compared to larger centralized units, with added submittals, purchasing and scheduling for each individual piece of equipment. Units contained in the core of the building also require the planning of the installation around the enclosure process to ensure that units are in place while there is still adequate access. Reducing the number of air handlers for Two Liberty Center could have potential benefits for reduced cost, simplified construction, and schedule reductions.

### *Analysis Goal*

The goal of this analysis is to centralize the HVAC system of Two Liberty Center by placing one or two larger units on the roof. The new unit or units for the HVAC system will be used to serve the office spaces on the 2<sup>nd</sup> through 9<sup>th</sup> floors, since design conditions for those floors are consistent. These changes will facilitate a reduction in the construction costs, a simplification of the construction process, and potential reductions to the construction schedule. The changes to the loading on the roof of Two Liberty Center due to the large equipment needed will require some redesign of the current structural system. This type of change to the mechanical system may also require changes to the leasing agreements for the future tenants to manage the utility costs for the building.



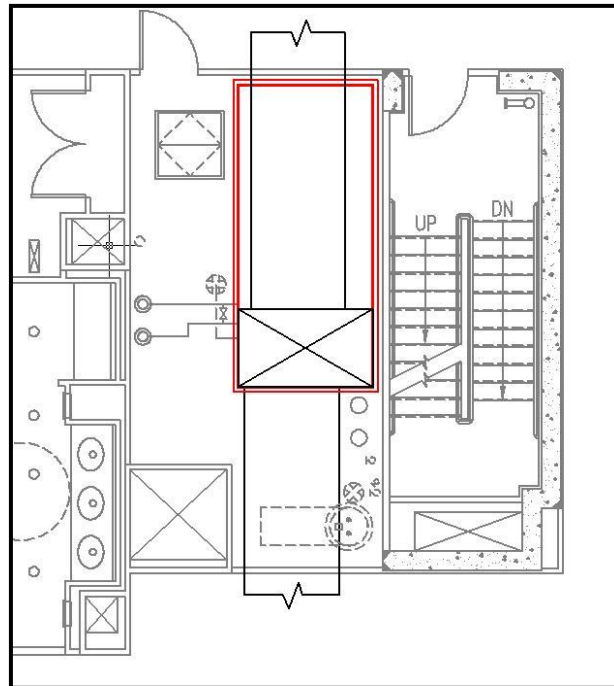
### *Analysis Method*

The following steps have been taken to design and analyze the proposed centralized HVAC system:

1. Collect data on existing equipment for the office spaces
2. Determine existing design conditions
3. Size and locate the distribution ducts for new equipment
4. Determine size and capacities for replacement units
5. Compare and contrast the new system to the existing

### *Existing System Details*

This analysis will focus on the 8 Factory-Built Chilled Water Air Handling Units which serve each of the 8 office floors for Two Liberty Center. These units are located in the core service spaces of the office floors with a large duct split from each unit to distribute air in a loop around the usable office space. Cooling capacity of the existing air handlers is designed for a 73° dry-bulb temperature. Air volume for the 2<sup>nd</sup> floor is set at 14,500 CFM, for the 3<sup>rd</sup> – 8<sup>th</sup> floors at 15,000 CFM, and for the 9<sup>th</sup> floor at 16,000 CFM: with all 8 air supply fans controlled by a Variable Frequency Drive. The drawing to the right illustrates the placement of the air handlers in the core of each floor, with the red indicating the unit itself.



*AHU location in office core*



## *Description of Replacement System*

### **System Layout**

The existing 8 units will be replaced by 2 larger identical units located on the roof of Two Liberty Center. Distribution from these units will be achieved through two main duct trunks penetrating down through the core of the building. The chase for these ducts will be located in the mechanical rooms on each floor, replacing the space previously occupied by the air handlers. Air distribution will be divided as the 2<sup>nd</sup> – 5<sup>th</sup> floors by one duct riser and the 6<sup>th</sup> – 9<sup>th</sup> floors by the other duct riser. Distribution through conditioned spaces will be achieved through the same duct system utilized by the existing mechanical system. This proposed revision to the mechanical system will provide performance equal to that of the existing system.

### **Air Distribution**

The following charts outline the air distribution design for this proposed revision to the mechanical system of Two Liberty Center:

*Supply Trunk 1: 2<sup>nd</sup> – 5<sup>th</sup> Floors*

Section	Duct Size (IN.)	Length (FT.)	Air Volume (CFM)	Static Pressure (IN./100')	External Static Pressure (IN. W.G.)
2-3	<b>32 x 30</b>	10.50	12100	0.15	0.016
trans	--	--	12100	--	0.100
3-4	<b>46 x 42</b>	10.50	24900	0.10	0.011
trans	--	--	24900	--	0.125
4-5	<b>56 x 50</b>	10.50	37700	0.08	0.008
trans	--	--	37700	--	0.150
5-PH	<b>68 x 60</b>	52.50	50500	0.06	0.032
Existing AHU	--	--	--	--	1.500
				<b>Total Pressure:</b>	<b>1.941</b>



*Supply Trunk 2: 6<sup>th</sup> – 9<sup>th</sup> Floors*

Section	Duct Size (IN.)	Length (FT.)	Air Volume (CFM)	Static Pressure (IN./100')	External Static Pressure (IN. W.G.)
6-7	<b>32 x 30</b>	10.50	12800	0.14	0.015
trans	--	--	12800	--	0.100
7-8	<b>46 x 42</b>	10.50	25600	0.10	0.011
trans	--	--	25600	--	0.125
8-9	<b>56 x 50</b>	10.50	38400	0.08	0.008
trans	--	--	38400	--	0.150
9-PH	<b>68 x 60</b>	10.50	52100	0.06	0.006
Existing AHU	--	--	--	--	1.500
				<b>Total:</b>	<b>1.914</b>

**Air Handling Units**

*(See Appendix 4.1 for Detailed Equipment Specs)*

Each of the proposed new air handling units are factory-built chilled water air handling units, with variable air volume supply from a forward-curved fan controlled by a variable frequency drive. Supply air volume is set at 51,500 CFM maximum air supply with a maximum external static pressure of 2.2 in. Since these new units are to be placed outdoors on the roof, the enclosure is designed with double-wall galvanized steel coated with a water-based polyurethane paint for weather-proofing. Units are to be installed on a factory-supplied 14” high roof curb fastened to the structure of the roof.



### Cost and Scheduling Analysis

The following chart outlines potential cost savings for the proposed mechanical redesign:

#### *Costs for Air Handling Units*

Qty.	Size (CFM)	Bare Costs		Total Costs	
		Material	Labor	Base	Including O&P
8	15000	\$88,800.00	\$20,200.00	\$109,000.00	\$128,000.00
2	51500	\$74,800.00	\$16,350.00	\$91,150.00	\$107,000.00
<b>Savings:</b>		\$14,000.00	\$3,850.00	\$17,850.00	<b>\$21,000.00</b>

Above figures are based on data from *RS Means Building Construction Cost Data* and are an accurate reflection of the costs involved in the purchasing and installation of air handling units for Two Liberty Center. The data displayed in red text indicates the costs of the proposed alternative mechanical system. Savings in the labor field are representative of the simplification of the construction process when installing air handlers on the roof instead of in the core of the building on each floor. These labor savings are mostly due to a reduction of labor hours from 620 for the 8 small units to only 492 labor hours for the 2 larger units. This magnitude of labor hour savings could translate into as many as 16 days of construction schedule reduction as outlined in the chart shown below:

#### *Labor for Air Handling Units*

Qty.	Size (CFM)	Labor Hours	Total	Scheduling Days
8	15000	78	620	78
2	51500	246	492	62
<b>Savings:</b>			<b>128</b>	<b>16</b>



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## *Conclusions*

This analysis of the existing system and proposed alternative system for the HVAC equipment for the office spaces of Two Liberty Center has presented an opportunity for schedule savings, cost savings, and overall simplification of the mechanical construction process. These benefits are easily achieved through this simple reconfiguration of mechanical equipment and their distribution systems.

The new configuration of the HVAC system for the office spaces would however require adjustments to be made to the lease agreements for the future tenants of Two Liberty Center. Instead of each tenant being responsible for individual utility bills for heating and cooling, the owner of the building would have to pay the utility bill for the entire building and build the costs into the monthly rent of the tenants. While this may not appeal to some owners, this style of lease agreement can create an opportunity for a building owner to reap the benefits of savings from more efficient building systems. Small upfront cost additions for increased efficiency in certain building systems can turn into significant long-term savings for the owner.

Implementing the proposed alternative to the mechanical system of Two Liberty Center would provide an opportunity for savings in cost and schedule while maintaining desired design conditions. The potential complications in leasing structures could outweigh the benefits, but that decision is one of preference by the owner of the building. Either way, this analysis has offered another opportunity for cost and schedule savings that could prove useful for many construction projects.