Spring 2022

Energy Analysis of Heating, Ventilation, and Air Conditioning Systems

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ENERGY ANALYSIS OF HEATING, VENTILATION, AND AIR CONDITIONING SYSTEMS IN COMMERCIAL BUILDINGS

By

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Final Report for 4600:497 Senior/Honor Design, Spring 2022

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22 April 2022

Project No. 33

Abstract

This design project studied the field of consulting engineering, particularly Heating, Ventilation, and Air Conditioning (HVAC) system design for commercial buildings. I completed an energy model for a building in West Virginia: Raleigh County Sheriff's Department. This building's HVAC has already been completed by the consulting engineering firm: Scheeser Buckley Mayfield. As I am a co-op at this company, they allowed me to use their original design as a basis for comparison and attempt to redesign the building to be more efficient. Load calculations, utility costs, energy consumption, and carbon footprint information were derived from this energy analysis. The energy model compared three systems: variable air volume (VAV) with electric reheat, variable air volume with hydronic reheat, and variable refrigerant volume (VRV). The original design used electric reheat VAVs. Based on the energy model, the VRV alternative consumed the least electricity, cost the least to operate, and had the lowest carbon footprint. While the technical data is only applicable for this building, similar conclusions can be drawn for similar buildings. To further develop the comparisons between the systems, a complete building HVAC design/layout was completed using the improved solution: VRV. The new design used much less ductwork, cutting the cost of ductwork and insulation in half. However, the VRV equipment itself has a higher material cost. However, it was found that VRV provides a more comfortable environment for occupants compared to VAV. Thus, there are many factors a building owner and engineer must consider when designing a building. Therefore, this project analyzed the decision-making process to organize thoughts and data between the three systems, allowing building owners to rank their priorities in a weighted decision matrix. Six factors were researched and compared in this project: Cost (initial and operating), comfort, environmental impact, maintenance, lifespan, and design process. It was concluded that while VRV might be the most environmentally friendly and economical solution for Raleigh County Sheriff's department, other building types and owners could have other needs that may outweigh the benefits of a VRV system.

Contents

1. Introduction

1.1 Goals

The goal was to analyze three commercial HVAC systems and weigh how they compare to one another depending on owner preferences and building type. I wished to explore the benefits and downsides of these systems and create a comprehensive way to evaluate them with a weighted decision matrix. Expanding upon my work experience, researching, and collecting data from the energy model, several factors were focused upon. The following chapters explore the energy model, the VRV system design, and the qualitative factors of HVAC systems involved in decision-making. The main deliverables include the energy model results, the full design set, the cost estimates, the weighted decision matrix, the written report, poster, and the learnings video.

1.2 Purpose

This project can show architects, engineers, and building owners that there are many factors to consider when selecting an HVAC system for a new building; initial cost should not be the sole deciding factor. Energy savings is becoming an important issue in our society and should be at the forefront of every building owner's mind. However, this is not always the case, sometimes economic constraints and other priorities get in the way of simply choosing the cleanest option. This project provides valuable information for both myself and for Scheeser Buckley Mayfield. If everyone involved in the design of a building understood the environmental and energy impacts of HVAC, more care would be taken in their decisions, and energy costs could be cut significantly, and the environment could benefit.

1.3 Methods

I approached this project by first running an energy model of the building with three different alternatives, one for each system. The only difference between the three alternatives was the main HVAC system used. Everything else, location, building construction, utility costs, and operating hours/occupancy info, remained the same to ensure an accurate comparison. The alternative with the lowest energy consumption, and therefore the lowest operating cost, would be considered the most successful. This option would then be designed in Revit and investigated further. The VRV system turned out to be the lowest operating cost, requiring much less electricity than the others. This result would be considered the "improved design" compared to the original electric reheat VAV design.

I worked in Scheeser Buckley Mayfield's office 4 hours per week to work on this project. This schedule was consistent from September to April. Additional time, about 1-2 hours per week, was spent outside of the office doing writing assignments, research, and brainstorming. More hours were spent on the project in April to write the report, make the video, and the poster. In the fall semester, the energy model was the focus, while the spring semester was filled with design tasks.

1.4 Team

I, Erica Ferguson, worked on this project individually, from a student standpoint. While no other engineering students assisted, my coworkers and technical advisor were assets to my success. I met with my advisor, David Peters, once every other week to discuss project progress and questions. He was helpful explaining the scope of my project, giving me ideas for my final deliverables, and providing insight from his industry experience.

Most of the technical work for my project took place at my desk at Scheeser Buckley Mayfield. My supervisor, Matt Knotts, met with me weekly to discuss my project. He gave me advice on how to proceed, explained technical concepts, and was always available for questions I had. Matt also checked over my design set to suggest edits and approve it. Other co-workers, including Joe Cavanaugh, were helpful to the energy modeling process. There are only 2-3 engineers in the office who are familiar with the software, and it was quite a challenge to figure out. Joe helped me configure the systems, plants, and utility costs in the model. I worked with a customer service representative from Trane after running into a few technical difficulties on this software. I also consulted the help of a sales representative from Daikin when using their VRV selection tool, WebXpress.

While I was the only student working on this project, it was certainly a group effort. The mechanical engineers at SBM, along with my advisor, were all supportive and eager to see the project succeed.

1.5 Project Costs

1.5.1 Material Cost

This project was a design/simulation, so there was no physical product created. In this industry, the product is the construction of a building, including the HVAC systems. This was not feasible for the means of this design project.

This project was free of cost to me and The University of Akron. My boss at Scheeser Buckley Mayfield allowed me to go into the office and use the computer at my desk to work on my project, including the various software SBM had access to. My coworkers also donated some of their time to help me out when I had questions. Aside from the basic Microsoft 365 package, previous SBM project designs, reference materials, and codes, the main computer programs that I used for this are Autodesk Revit and Trace 3D.

- A subscription to Autodesk Revit costs $320 per month. I only used Revit in the spring semester, so this would total to about $1,280.
- A single license to Trane’s Trace 3D Plus Full Version costs $2,345, and this is an annual cost.

- A computer was necessary to run this software, but that cost can be neglected in this cost estimate since most people are assumed to have a computer, and the costs vary so widely.

Total Estimated Material Cost: $3,625.

This neglects computer cost, help of co-workers, basic Microsoft software, and transportation to the office.

1.5.2 Labor Cost

Future Salary at SBM: 33 dollars per hour

Approximate total hours working on this design project: about 200

Total Estimated Labor Cost: $6,600

Total Estimated Cost (Materials + Labor) = $10,225

1.6 Engineering Standards

The American Society of Heating Refrigeration and Air Conditioning Engineers, which I will furthermore refer to as ASHRAE, has been providing the main standards for this industry for over 35 years. They are widely accepted across the country, and release publications every year with updated data and standards. Consulting engineers' reference ASHRAE codes every day to obtain information like climate data, occupancy data, ventilation requirements, energy standards, and more. These ASHRAE handbooks[1,2] are arguably the most important tool for engineers to successfully design a building's HVAC system. I reference both ASHRAE 90.1 and ASHRAE standard 62 in this report. Although these are the only direct references, fundamentals of comfort and general recommendations set forth by ASHRAE are built into this project's design.

While sometimes I search up the code and read from ASHRAE directly to gain information, its data is also built into the energy modeling software I used. Trace 3D uses ASHRAE data on template building constructions, energy efficiency standards, and accepted comfort levels for occupants. The calculations performed within the software directly reference these codes. The airflow sheet SBM uses to display ventilation data (Appendix 12) also directly references ASHRAE standards, providing minimum outside air, balances air based on occupancies and room types, and more.

Other standards such as OSHA, ASTM, and more would be expected to be followed if this building were to be constructed. Since this project is a theoretical design, only the general design requirements of ASHRAE were explored.

2 Energy Model

The goal was to create a 3D computer model of the building and then run load, energy, and economic analysis of it as if it were operating. Scheeser Buckley Mayfield has access to the software, Trace 3D Plus. This software, produced by TRANE, was the tool used to create the model. Once the building is drawn and the inputs are finished, the program can calculate all loads, operating conditions, and cost analysis within a matter of minutes. It is significantly quicker, more efficient, and credible than calculating by hand. Below, figure 1, is the architectural floor plan I traced and scaled when creating the model.

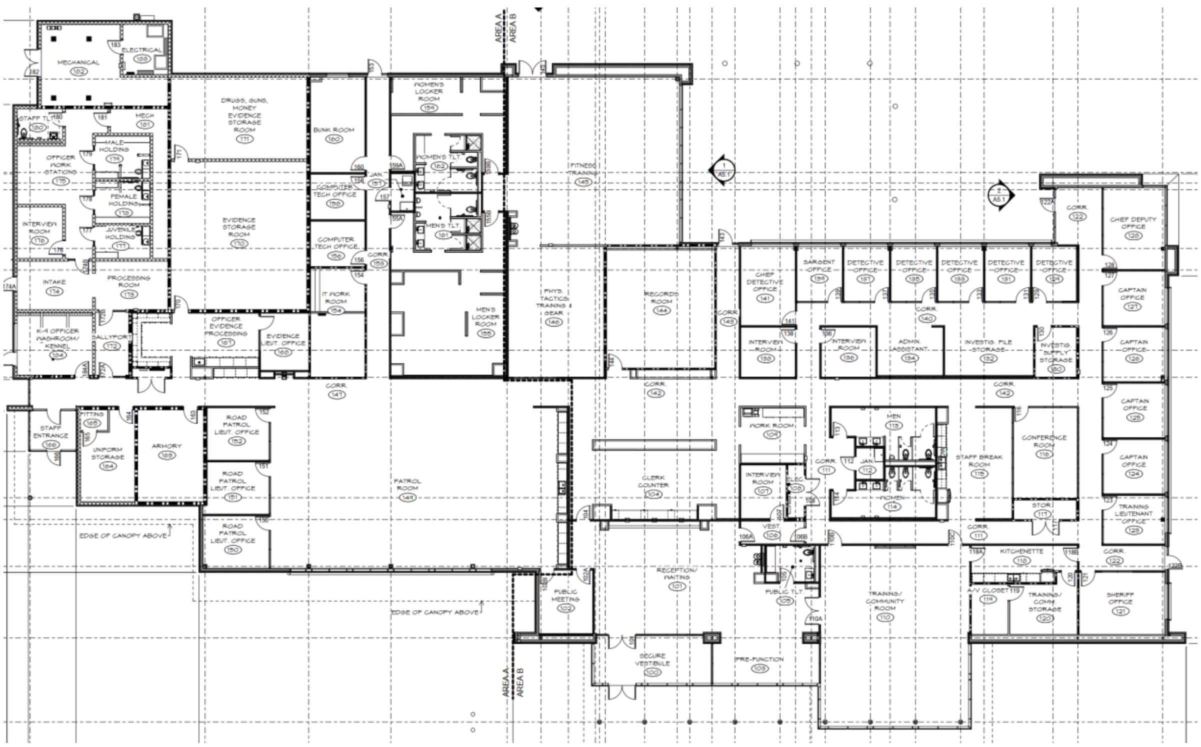


Figure 1: Architectural Floor Plan used in to Trace in the Energy Model

2.1 Energy Model Inputs

2.1.1 Building Construction

The construction information was found in the original load calc for this project and confirmed in emails from the building owner. As seen in appendix 19, the windows are to have a U-factor of 0.541. The exterior walls are to be made from brick, with details as shown in appendix 20. The interior walls are made from Gypsum. These construction materials are nothing out of the ordinary for this type of building, making it the perfect model for this project. See figure 3 below for model construction.

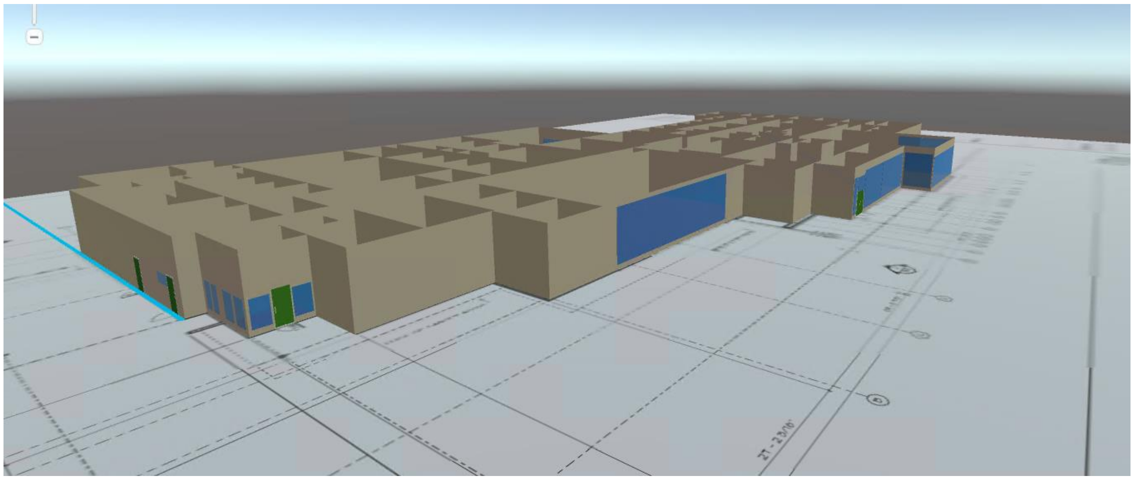


Figure 2: Building Model with Walls and Windows

These wall and window constructions are vital to the energy calculations, as they dictate the heat transfer through the walls. The laws of convection and radiation are built into the software to calculate the heat transfer of each wall/window depending on the time of day and climatic location. A building with thicker bricks will be more insulative than a building with thinner walls. This would drastically affect the required heating and cooling to keep occupants inside comfortable. The code-required levels of comfort/temperatures rooms must be maintained; they are explained in the ASHRAE handbook section 90.1 and 62, and built into the Trace 3D software[1,2].

2.1.2 Loads

Load information including people, lighting, equipment, and occupancy hours are vital for HVAC engineers to understand before designing a building. The energy model relies on this data, along with the building construction, to determine how much heating/cooling each room needs. Firstly, the expected average number of people to occupy each room were input. ASHRAE standard 62[1] codes lists this information in the form of "___ persons per square foot" of a certain type of room. Typically, restrooms, stairways, and corridors are input as zero, while gyms/training rooms are designed for many more. Occupancy loads were also important, especially for this building. Some rooms, such as the patrol room and server rooms, operate 24 hours a day, 7 days a week. The energy model needs to know generally how many hours the building needs heated and cooled, based on when people will be in the building for how long.

Next, the equipment and lighting loads were analyzed. Equipment such as computers and refrigerators give off heat, changing the heating/cooling loads for a room. Brightly lit rooms such as offices and meeting rooms give off more heat than dim rooms such as storage or maintenance. I typed in the required lighting loads for each room type in terms of Watts per square foot. Equipment loads were input similarly with either Watts per square foot or the average number of sensible watts expected. For example, small offices with 1 desk were listed as 150 Watts due to the expected computer on the desk and other potential small loads, such as a phone or laptop.

2.1.3 Systems

Three heating and cooling systems were studied in this project. Based on my experience at Scheeser Buckley Mayfield thus far, and coworker recommendation, these are some the most widely used systems today. This section provides a brief description of each system.

2.1.3.1 Variable Air Volume (VAV)

Variable Air Volume systems deliver conditioned air to a zone of a building at a constant temperature; SBM typically designs them for 55 degrees Fahrenheit. The volumetric flow rate of air to the zone is chosen based on the heat gain from the loads as discussed in section 2.1.2 above[3]. These airflows are determined from the load calc, providing values in cubic feet per minute (CFM). These are the airflows labeled on the floorplans at each diffuser. Each branch duct downstream of VAVs should be set to the design CFM using balance dampers. A packaged rooftop unit or custom air handling unit conditions the air, bringing in outside air and return air. This conditioned air is called "supply air" or SA for short. The air is transported throughout the building in ductwork and branches off to several VAV terminal units. These terminal units condition the supply air once more and balance to the correct airflow. Smaller ductwork runs downstream of the terminal unit, branching off to one or more diffusers. These diffusers lie in the ceiling or in the walls, providing air directly to the room.

A few years ago, the engineers at SBM designed this building with an electric reheat VAV system. This provides a reheating of the air in the terminal unit just before it is delivered to the space, to meet heating demands. Most VAVs are typically cooling only[3]. There are two types of reheat in VAV boxes. The original building design utilizes an electric heating coil, powered solely by electricity. The other option, which was also studied in the energy model, utilized a heating water system; a hot water heating coil reheats the air. This hot water method is older fashioned, and requires more piping and equipment, but it was studied because of its popularity.

The design for these two systems would be fairly similar to one another. The main difference is the need for heating water supply and return piping and a boiler plant in the hydronic reheat system. There are many differences in other aspects of these systems which will be discussed in section 4.3.

It is important for the design engineers to properly zone the VAV boxes. It is often unnecessary and expensive to have one VAV box per room. Unless it is a significant room such as a conference room or a gymnasium, there are typically multiple rooms served by one VAV box. The designer must consider many factors such as room uses, exterior exposures, room sizes, and more. For example, three small offices along the east wall of a building would be grouped on the same terminal unit, since the room types and exposures are along the same exterior wall. Interior rooms are easier to group together since there are no exterior wall exposures affected by sunlight/weather. The zoning was already done from the electric reheat design, since the ductwork layout is the same, so there was no need for me to redesign the zoning for hydronic reheat alternative 2.

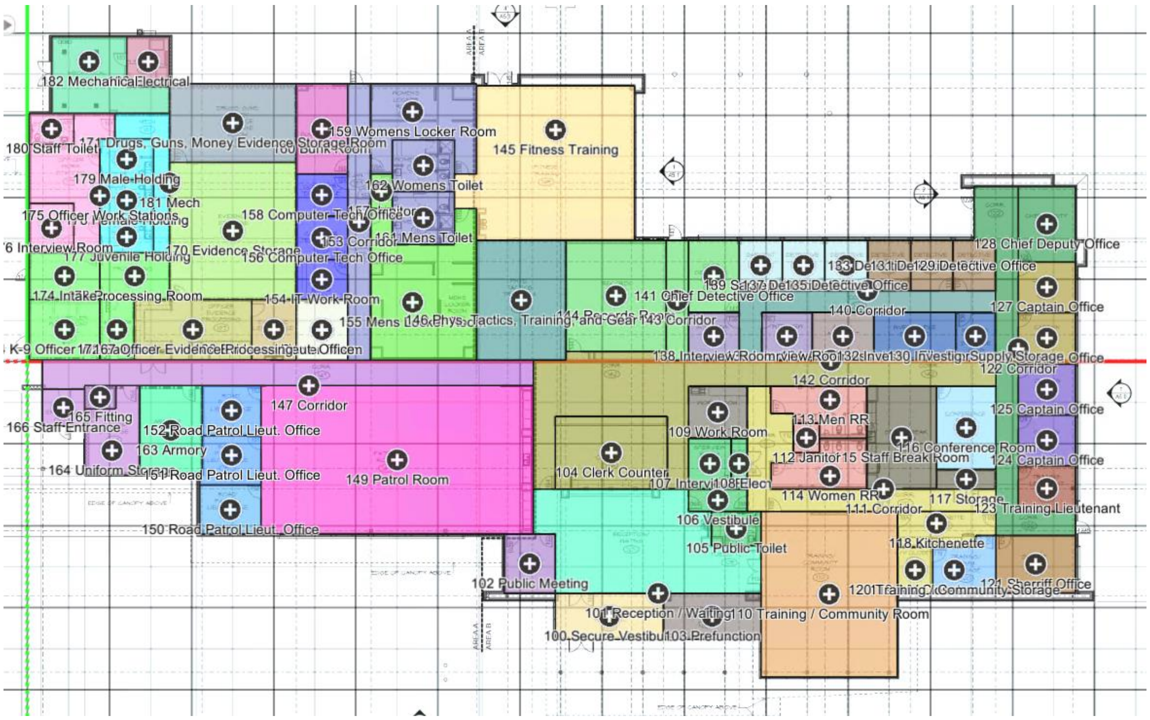


Figure 3: VAV Zoning in Energy Model

2.1.3.2 Variable Refrigerant Volume (VRV)

VRV systems utilize refrigerant R-410A as the heat transfer fluid and the working fluid. These systems are named due to their ability to control the refrigerant flow through multiple evaporator coils[4]. Rather than air being conditioned on the rooftop and then circulated throughout a building, the air is conditioned in a smaller indoor unit near each zone and delivered directly to the space. This eliminates the need for a lot of ducts. Most of the ductwork used in VRV systems belong to the outdoor air system, leading to the makeup air unit on the roof. Each space requires a certain amount of outdoor air based on ASHRAE Standard 62.1: Ventilation for Acceptable Indoor Air Quality[1]. Refrigerant piping is routed throughout the building to each indoor unit and up to the associated outdoor unit(s). These outdoor units are capable of simultaneous heating and cooling, adapting to the needs of each zone in the building. Zoning for VRV systems is similar to the zoning for VAV systems, with minor differences due to their structure. Branch selector boxes are also necessary, as they help control the refrigerant flow as it branches off to each zone. These systems are powered solely by electricity, which will prove to be beneficial in the economic analysis later in this report.

There are many types of indoor units. The two used in this project are ceiling cassette and concealed ducted. The type of room and heat requirement was used to determine which type to use in each zone. See Figure 4 for my markups on the zoning of this building. VRV systems can be air-cooled or water-cooled. This project employs the air-cooled method, where several compressors connect to the refrigerant piping loop[4].

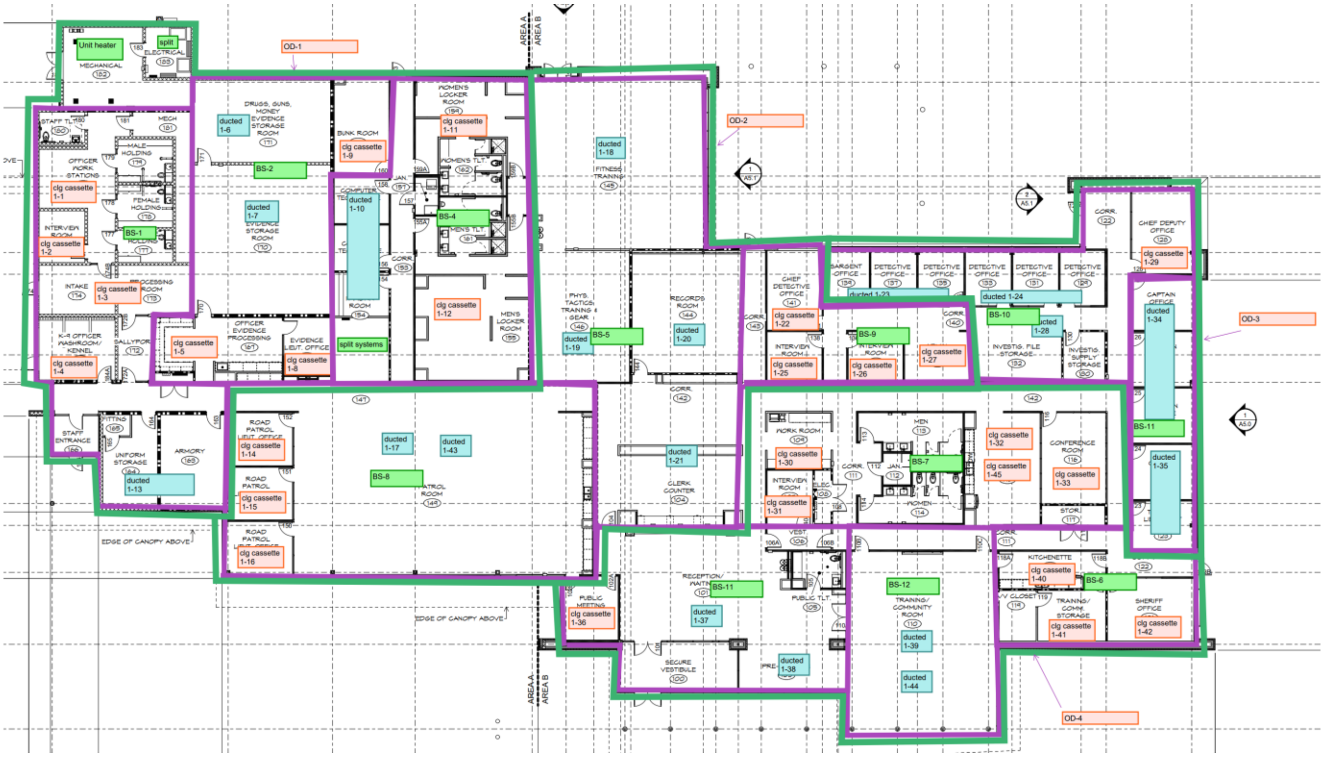


Figure 4: VRV Zoning

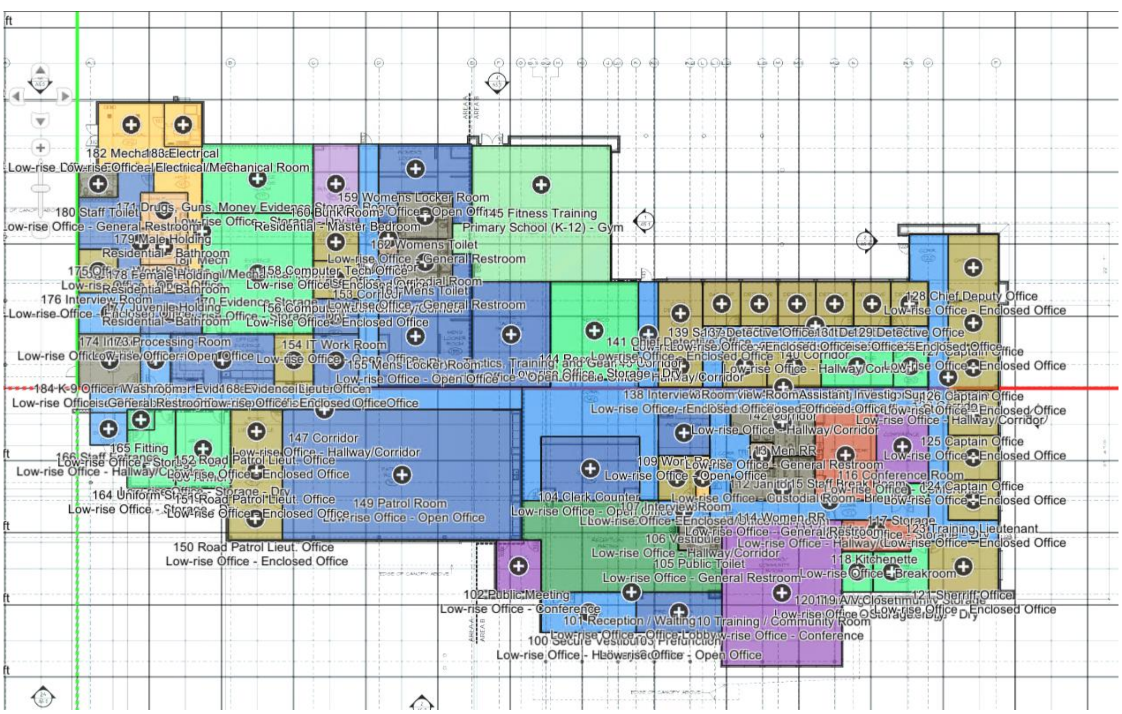


Figure 5: VRV Zoning in Energy Model

2.1.4 Location

The location of the building is essential to Trace 3D's load calculations. Location determines climate patterns, which is a huge contributing factor to HVAC required loads. Colder climates are designed with systems that heat most of the year, and warmer climates are designed for cooling. The building in question, Raleigh County Sheriff's Department, is located in Beckley, West Virginia. Trace 3D used the Beckley Raleigh County Memorial airport for its weather location. West Virginia's climate is comparable to Ohio's, varying from degree cooling to degree heating days as they get all seasons. The weather data is found in Appendix 15.

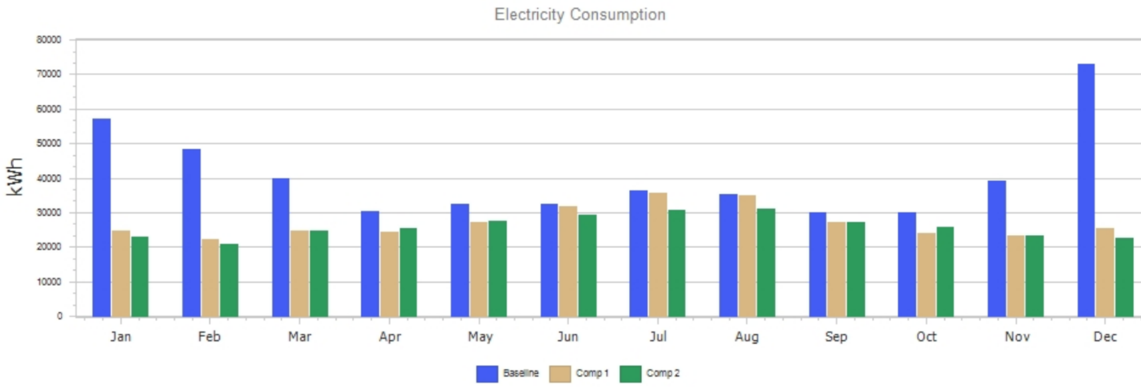
Location is a factor that widely varies between buildings, affecting the way the systems run. The HVAC systems are not the same in Florida as it is in Ohio, for example. This is due to the degree heating and degree cooling days. Ohio experiences a much wider climate variety than Florida does, so their systems need to be ready to heat or cool, sometimes to an extreme level depending on high and low temperatures. This energy model would yield drastically different load and energy results if the location was changed from a mild climate to a warm climate or a cool climate. These particular results, for the building in West Virginia, should only be compared to buildings in similar climates, such as Ohio.

2.1.5 Utilities

I researched the water, electricity, and natural gas rates for Raleigh County West Virginia, but the results were inconsistent on various websites. As a solution, I worked with Joe Cavanaugh, a coworker who has experience with researching utility costs, and he showed me the utility rates he used on a similar project. He recently completed an energy model for a commercial building in Wheeling, West Virginia, and concluded that the utility rates would be very close to the rates for my building. Therefore, I decided to use the cost data from Joe as it was more reliable than the websites I found; his data was straight from a utility company. Note that the utility data used is from Wheeling, West Virginia in 2019. It does not account for inflation, as that is challenging to predict and unnecessary for the purposes of this project. Appendices 16-18 list the utility costs used.

2.1 Outputs

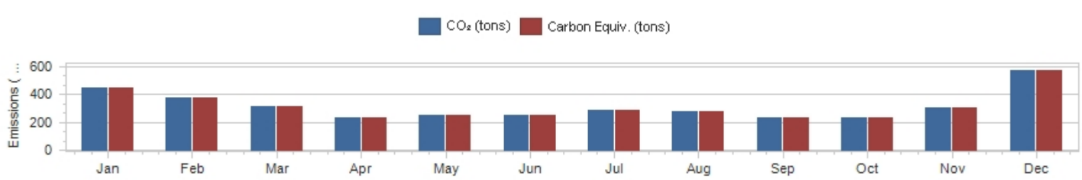
Trace 3D produced dozens of documents highlighting cost, energy, and load data. This information came in the form of tables and graphs. It is important to note that the numbers generated in this project are not meant to be exact if this building were to be constructed. The intent of the economic data below is to compare between alternatives. In reality, the costs would likely be higher due to inflation or an accurate utility bill received from Raleigh County. The values below should serve as estimates, focusing on the relative differences between each alternative. Figures 6-10 are several of the most significant reports produced by the energy model.



	Jan (kWh)	Feb (kWh)	Mar (kWh)	Apr (kWh)	May (kWh)	Jun (kWh)	Jul (kWh)	Aug (kWh)	Sep (kWh)	Oct (kWh)	Nov (kWh)	Dec (kWh)
Baseline	57,470	48,676	39,942	30,576	32,567	32,795	36,524	35,583	30,233	30,136	39,351	73,087
Comparison 1	24,910	22,584	24,752	24,516	27,417	32,120	35,664	35,146	27,509	24,229	23,405	25,628
Comparison 2	23,045	21,175	25,013	25,565	27,621	29,446	30,893	31,139	27,414	26,084	23,625	22,794

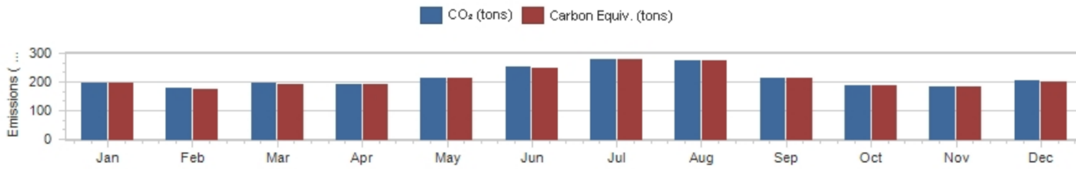
Figure 6: Monthly Electricity Consumption

Electric reheat VAVs require the most electricity to power, especially in the cooler months (October-March) where the electric reheat is most needed on the terminal units. In the warmer months, the three systems are more similar in electrical demand and consumption. This is because the reheat coils on the VAV boxes become unnecessary when the goal is to cool the air. Overall, comparison 2 remains consistent in its low electrical consumption compared to the others.



Emission Data		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
CO_2	(tons)	453.31	383.94	315.05	241.18	256.88	258.68	288.09	280.67	238.47	237.7	310.39	576.49	3840.84
CH_4	(tons)	52.35	44.34	36.38	27.85	29.66	29.87	33.27	32.41	27.54	27.45	35.84	66.57	443.52
N_2O	(lbs)	15449.16	13085.21	10737.17	8219.6	8754.75	8816.07	9818.37	9565.39	8127.32	8101.13	10578.53	19647.35	130900.06
NO_x	(lbs)	814.63	689.98	566.17	433.41	461.63	464.87	517.71	504.37	428.56	427.17	557.79	1036	6902.3
SO_2	(lbs)	1084.65	918.69	753.83	577.08	614.65	618.95	689.32	671.57	570.6	568.77	742.69	1379.39	9190.17
Hg	(lbs)	0	0	0	0	0	0	0	0	0	0	0	0	0
PM	(lbs)	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Consum.	(gal)	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon Equiv.	(tons)	451.96	382.81	314.11	240.46	256.12	257.91	287.23	279.83	237.76	237	309.47	574.78	3829.45

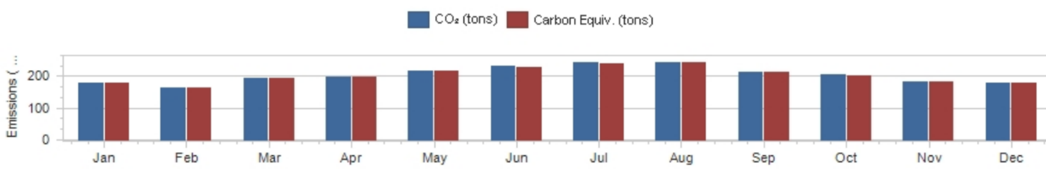
Figure 7: Alternate 1 (Electric VAV) Carbon Footprint



Emission Data		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
CO_2	(tons)	199.89	181.16	197.39	194.13	216.96	253.37	281.31	277.22	217.28	191.92	186.49	206.71	2603.83
CH_4	(tons)	22.69	20.57	22.55	22.33	24.97	29.26	32.48	32.01	25.06	22.07	21.32	23.34	298.64
N_2O	(lbs)	6696.39	6071.24	6654.04	6590.54	7370.21	8634.49	9587.22	9448.02	7395.05	6513.2	6291.93	6889.51	88141.89
NO_x	(lbs)	358.78	325.18	354.46	348.77	389.8	455.34	505.52	498.18	390.42	344.78	334.9	370.88	4676.97
SO_2	(lbs)	470.18	426.26	467.18	462.71	517.45	606.21	673.09	663.33	519.19	457.28	441.76	483.74	6188.35
Hg	(lbs)	0	0	0	0	0	0	0	0	0	0	0	0	0
PM	(lbs)	0.44	0.37	0.26	0.09	0.09	0	0	0	0.04	0.11	0.24	0.57	2.23
Water Consum.	(gal)	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon Equiv.	(tons)	196.83	178.43	195.25	193.01	215.81	252.61	280.47	276.4	216.42	190.76	184.58	202.79	2583.36

Figure 8: Alternate 2 (Hydronic VAV) Carbon Footprint

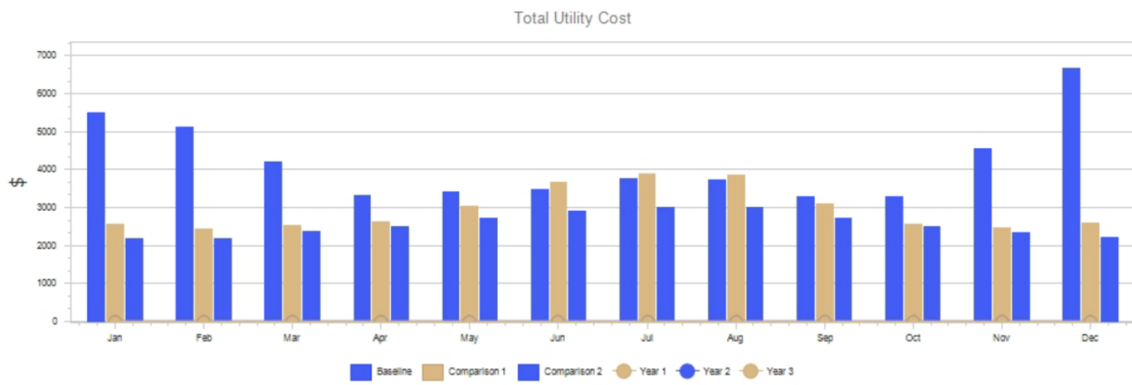
Carbon Footprint



Emission Data		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
CO_2	(tons)	181.77	167.03	197.29	201.65	217.86	232.26	243.68	245.62	216.23	205.74	186.35	179.79	2475.27
CH_4	(tons)	20.99	19.29	22.78	23.29	25.16	26.82	28.14	28.36	24.97	23.76	21.52	20.76	285.83
N_2O	(lbs)	6194.97	5692.42	6723.97	6872.49	7425.01	7915.61	8304.79	8370.86	7369.46	7011.82	6351.03	6127.42	84359.88
NO_x	(lbs)	326.66	300.16	354.55	362.37	391.52	417.38	437.9	441.39	388.59	369.74	334.88	323.09	4448.24
SO_2	(lbs)	434.93	399.65	472.08	482.5	521.28	555.74	583.06	587.71	517.4	492.29	445.88	430.19	5922.7
Hg	(lbs)	0	0	0	0	0	0	0	0	0	0	0	0	0
PM	(lbs)	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Consum.	(gal)	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon Equiv.	(tons)	181.23	166.53	196.71	201.05	217.22	231.57	242.95	244.89	215.59	205.13	185.8	179.26	2467.93

Figure 9: Alternate 3 (VRV) Carbon Footprint

Note that these graphs each have different y axis limits, so they must be inspected carefully. Overall, the electric reheat system has the highest carbon footprint, and the VRV system has the lowest. Alternates 2 and 3 emit nearly the same carbon equivalents, totaling 2583.36 tons and 2467.93 tons, respectively. The carbon equivalent for the baseline system is 3829.45 tons. This data is important when an environmentally conscious building owner, with room in the budget to prioritize it, aims for a system with a lower carbon footprint.



	Jan ($)	Feb ($)	Mar ($)	Apr ($)	May ($)	Jun ($)	Jul ($)	Aug ($)	Sep ($)	Oct ($)	Nov ($)	Dec ($)	SD Year 1	SD Year 2	SD Year 3
Baseline	5,498	5,120	4,218	3,328	3,433	3,490	3,793	3,734	3,310	3,304	4,578	6,691	$1029.13	$1029.13	$1029.13
Comparison 1	2,563	2,440	2,555	2,642	3,047	3,669	3,916	3,876	3,101	2,581	2,483	2,601	$538.22	$538.22	$538.22
Comparison 2	2,192	2,196	2,380	2,523	2,733	2,916	3,027	3,025	2,739	2,528	2,349	2,238	$298.97	$298.97	$298.97

Figure 10: Total Utility Costs

As seen in figure 10 above, the VRV system has the lowest total utlitiy costs, followed by the hydronic reheat. The electric reheat VAVs are the most expensive to operate. This is important to note since these are typically the lowest up-front cost, so it can easily decieve owners without proper research. These numbers will be more expensive or less expensive based on geographical location / local utility costs; however, relative costs should remain the same.

3. Design Drawings

To show the full effects of the improved HVAC solution, I designed the VRV system after the Energy Model was completed. I carried this out in a similar fashion to any other project at SBM, using the project data and architectural model from the original project.

3.1 VRV Sizing

SBM utilizes DAIKIN's software to specify their VRV indoor units, outdoor units, and branch selector boxes. With a few datapoints like heating load, cooling load, system temperatures, the software selects the best available DAIKIN product. First, I created a PDF of the floor plan and zoned out the VRV indoor units. Depending on several factors including room size, room type, and exposure to exterior walls, I zoned the VRV units appropriately. Concealed ducted units are best for larger spaces, while ceiling cassettes are better for single rooms where the air from the unit can reach most of the space (such as offices). See figure 4 for VRV zoning floor plan. To easily visualize the heating loads for each room, which drives the indoor unit selections, I created an excel sheet: Appendix 11. I linked the total heating, total cooling, and sensible cooling loads (all in BTU/hr) to the Airflow sheet used with the original project. The airflow sheet is a comprehensive excel sheet providing all heating and cooling requirements linked to the load calc (Appendix 12).

Each indoor unit was designed with an entering dry bulb temperature of 75.0 deg F for cooling, 68.0 deg F for heating, and a relative humidity of 50%. The required heating and cooling capacities as well as the required sensible capacity in BTU/hour were obtained from the airflow sheet.

Once the system was satisfied in WebXpress, reports were printed. Indoor unit, outdoor unit, and branch selector box schedules were exported (Appendix 9 and 10), along with flow and wiring diagrams (Sheet set M5.X in Appendix 21). Some of the VRV products also had Revit families. All these were used in the Revit model as explained below.

3.1.1 Makeup Air Unit

Variable refrigerant volume systems typically require a makeup air unit to provide fresh outdoor air to each space, in addition to the heating and cooling loads provided by the indoor units. My supervisor advised me to use a 100% outdoor air system for this building. This means the makeup air unit will be circulating fresh outdoor air only. With this being a sheriff's department, there is a lot of exhaust air, as seen by the original building design. This exhaust air ductwork and exhaust fans were not edited when designing the VRV system, they are mostly independent of each other. After some air balancing calculations, displayed in equation 1 below, most of the air is reasonably exhausted to the outdoors.

Supply – exhaust – 100 CFM per Exterior Door = Relief Air (1)

It was determined that energy recovery was unnecessary for this design due to the high amount of hazardous exhaust coming from this building, which nearly balanced the supply air on its own. According to ASHRAE Standard 90.1[2], there are several exceptions for systems requiring energy recovery. This building meets two of these exceptions:

1. "Systems exhausting toxic, flammable, paint, or corrosive fumes or dust"
2. "Where the largest source of air exhausted at a single location at the building exterior is less than 75% of the design outdoor airflow rate"

Both exceptions are satisfied. The first being due to the large drugs, guns, and money storage room on the northside of the building. There are toxic and volatile substances stored in that room that need to be exhausted to keep away from the public, so the scent cannot be picked up throughout the building. The second exception listed above is satisfied through equation 1 above.

A run around energy recovery loop could be considered for this design due to the hazardous nature of a large amount of the exhaust air, but up-front operating costs may prove this to be impractical. Further investigation would be required, and it is assumed that this would have minimal impact on the current analysis as there are multiple exhaust air streams; full energy recovery from these would be difficult and costly to achieve. Under normal circumstances, a plate frame heat exchanger or energy recovery wheel would have been utilized.

Once it was determined that the makeup air unit shall be 100% outdoor air, no relief air, it was time to size the units. One unit was used for each half of the building. MAU-1 would serve the west side (area A), and MAU-2 would serve the east side (area B). My supervisor has an excel sheet he uses to size these units. Screenshots of the sheets can be seen in Appendix 3 & 4. Equations built into the sheet are listed in the sections below.

Heating Coil

A few parameters were needed to input into the sheet: supply air (CFM), outside air (CFM), return air (CFM), outside air temperature (deg F), return air temperature (deg. F), supply air temperature (deg. F), and mixed air temperature (deg. F). MAU-1 had 2700 CFM for both SA and OA, with no return air. MAU-2 was 2300 CFM. These values came from the airflow ventilation spreadsheet created in the original project (Appendix 13 & 14). It is linked to the load calc of the building. Furthermore, the OA temp was assumed to be 0 degrees on its coldest days based on a combination of ASHRAE Fundamentals and real-world experience. The coldest days are often cooler than what the handbook states they are, so 0 degrees is used to be safe. The RA and SA temps are assumed to be 70 degrees, the temperature of the air in the conditioned space. The mixed air temperature is 0 degrees, since that is the temperature of OA, and there is no RA. In typical HVAC applications, Mixed Air = Outside Air + Return Air. The heating coil calculations are shown in equations x and x below, indicating the input and outputs, assuming the unit is 80% efficient.

Heating Input (BTU) = (SAT – MAT) x 1.08 x Supply Air CFM (2)

Heating Output (BTU) = Heating Input x 0.8 (3)

Cooling Coil

The same SA and OA CFMs are utilized for this calculation, 2700 and 2300 CFM. For the cooling coil, it is necessary to obtain the outside air dry bulb and wet bulb temperatures; once again, these are found using the specific location data from the ASHRAE Fundamentals Handbook. For the closest location to Raleigh County, Yeager West Virginia, the dry bulb temp is 92 degrees and 73 degrees wet bulb on its hottest days. This is considered the OA temperature, and the Mixed Air temperature, as explained in the heating coil section above. The supply air temp is 55 degrees dry bulb and 54.8 degrees wet bulb. These are typical numbers for any project. Air must be cooled to 55 degrees leaving air temperature for dehumidification purposes. The unit leaving air temperature will be 70 degrees, which is usually our design point.

The next step in sizing the cooling coil was to calculate the enthalpies of the outside and supply air. A psychrometric chart software by Elite was used to find these values. The mixing and cooling processes were plotted on the charts using the given state points of OA, MA, and SA explained above. Photos of the psychrometric charts are in Appendices 1 and 2. Once the processes are plotted, the software displays the corresponding enthalpy values, which I input into the excel sheet. The sensible cooling and total cooling loads can then be calculated using the following equations.

Qsensible (BTU/hr) = (MAT DB – SAT DB) x 1.08 x SA CFM (4)

Qtotal (BTU/hr) = (OA enthalpy – SA enthalpy) x 4.5 x SA CFM (5)

Total Cooling (Tons) = Qtotal (BTU/hr) / 12000 (6)

DAIKIN has catalogs available online. After a bit of browsing, it was determined that the DAIKIN Rebel DPS015 and DAIKIN Rebel DPS012 are the best models for MAU-1 and MAU-2, respectively.

3.2 Revit

Following suit of our other projects, Autodesk Revit was used to exhibit the system design on sheets as shown in appendices 13,14, and 21. I started by creating a copy of the original project's Revit file and renaming it for my project. This way I was able to build upon the same architectural model and keep all the basic project notes, details, and supplemental equipment that comes with both designs. I deleted everything associated with electric reheat VAVs including VAV boxes, ductwork, details, temperature controls, schedules, and notes.

The sheets were already setup, so once the electric VAV systems and notes were deleted, I was able to load in the VRV families. Each zone had an indoor unit and associated outdoor unit. Makeup air was necessary for this building, to accompany the indoor units. I put in diffusers and ductwork to distribute the appropriate amount of air to each room. The required CFM for makeup air was found in the Airflow sheet. The airflows for this air were low, so the ductwork was minimal. With this 100% outdoor air requirement, comes a makeup air unit. This unit was to be located on the roof connecting the supply and return air ductwork for the whole building. This unit was determined to need energy recovery because of its high load.

The main HVAC sheets feature the floor plan, plan notes, coded notes, a room legend, and a title block. This is all typical for any SBM project, so it was great practice and makes this senior design project look like a real construction job. While some of the notes remained the same for the original design, I edited and added many of them to fit the new system.

Due to the time restraints and emphasis on the energy model rather than the floor plans, the refrigerant piping was not drafted into Revit. Instead, to estimate the cost of the piping, my supervisor provided a dollar per square foot amount for this piping in a similar building from a past project. This number was used in the cost estimate in appendix 8. Ideally, there would be refrigerant supply and return piping routed from the outdoor unit and branched off to each indoor unit throughout the building. Furthermore, the outdoor unit Revit families were exported from DAIKIN's software and added to the roof plan on sheet M1.3 and M1.4 of appendix 21.

The schedules produced in WebXpress (Appendix 9 and 10) were used to fill out the schedules in Revit. I took relevant details from SBM's master detail book, and some from previous VRV projects. Details, temperature controls, schedules, and piping and wiring diagrams can be found on sheets M2.0-M5.3 of the design set in Appendix 21.

4. Findings

4.1 Cost Estimates

SBM completes their cost estimates using an excel sheet pre-loaded with costs per item. The quantity of items such as ductwork, diffusers, valves, and piping are input, and a total cost is generated. Labor costs are also included. These are not intended to be a specific value applicable to all similar buildings. These are highly dependent on the size of the building and of building use/occupants. Appendices 5-8 are the cost estimate excel sheets with detailed inputs and values.

The cost estimates helped draw conclusions about the initial cost of these systems. The cost of ductwork and insulation is cut in half with the new VRV design compared to the original electric reheat VAVs. This is beneficial not only from a financial standpoint, but also for the construction, architectural, and mechanical design team. This is explained in section 4.2 below.

4.2 Design Comparisons

A quick glance at the improved VRV design (Appendix 21) reveals that it is less-crowded than the original design (Appendix 13 & 14). This is due to the reduced ductwork. Smaller ductwork makes the design process much easier, as well as the construction process. Based on experience, engineers often need to coordinate with the architects to negotiate ceiling space, chases for duct shafts, and structural beam adjustments. This is mainly due to the need for large ductwork networked throughout the building and up to the rooftop units. With smaller duct mains in the VRV design, less ceiling space is needed, making the jobs of architects easier. With less ductwork also comes less duct-crossings/coordination issues with plumbing or electrical equipment. Large ducts often need their own shafts or corridors to run in, to avoid any collisions with other disciplines. VRV uses less ductwork, reducing this issue and reducing the cost of duct elbows or shafts required.

Note that a complete design would include refrigerant piping throughout the building to each indoor unit, which is not included in the design set for this project; but these pipes are small in diameter, so it would not be a significant inconvenience. The main concern with refrigerant piping is maintenance. Refrigerant can be dangerous if leaks occur, so maintenance teams would have to be extra careful about buildings with VRV design[5]. Hydronic VAVs would also require extra piping for their heating water supply and return lines to between the boiler plant and the VAV boxes. Designing a boiler plant (boilers, pumps, expansion tank, air separator, buffer tank, etc.) can be a time-consuming process for consulting engineers. It also requires an adequate space such as a boiler room in the building to safely connect all the equipment with the piping. Extra maintenance could also be significant to hydronic reheat VAV system due to the boiler plant and piping. The electric VAVs eliminate the need for refrigerant or HWS/R piping, but the ductwork is still large and abundant, nonetheless.

4.3 General Comparisons

After completing the energy model, additional research was necessary to gain a full scope of the different systems. While energy efficiency and costs are certainly important to most owners, other factors are always in play. There are many other factors, but the ones I focused on for this project are: Initial cost, operating cost, environmental impact, comfort, lifespan, maintenance, and design process. I read several articles and compiled the main points in table 6 below[3,4,5]. Many of which are already discussed in this report, derived from the energy model, or learned from experience in the field.

	Electric VAV	***Hydronic VAV***	***VRV***
Initial Cost	Lower installation costs compared to hydronic	Higher installation costs	5%-20% higher initial cost Lower installation costs compared to VAV
Operating Cost	**highest operating cost based on energy model**	Depending on fuel for boiler/hot water heater, lower operating costs than electric	Lowest in energy consumption, mainly requires electricity. **Lowest cost based on energy model.**
Environment	highest energy consumption	requires natural gas	most energy efficient
Comfort	Potential for air quality problems without proper care Difficult to maintain outdoor air requirements Separate heating systems are often needed for colder climates/exterior rooms cooler / more accurate temperatures to the design point	Potential for air quality problems without proper care Difficult to maintain outdoor air requirements least comfortable option	Most comfortable option, simultaneous heating or cooling per zone, quiet operation, advanced controls, speed modulation, and partial load operation
Lifespan	20 years	20 years	lasts 10-15 years
Maintenance	dampers, actuators, filters, and sound attenuators increase maintenance	Valves and piping add a lot of maintenance, leaks dampers, actuators, filters, and sound attenuators increase maintenance	Fewer breakdown = less downtime Refrigerant leaks can be dangerous
Design Process	Most simple for mechanical engineers. Mainly only VAVs, air handlers, and ductwork.	Need to design boiler plant and heating water piping throughout building	Need to layout refrigerant piping, branch selectors, and makeup air Minimal large ductwork, great for buildings with little ceiling space

Table 1: System Comparisons Based on Research, Energy Model, and Experience

After researching the pros/cons of each system, I chose 5 criteria that I found the most significant and created an objective tree for commercial building HVAC design.

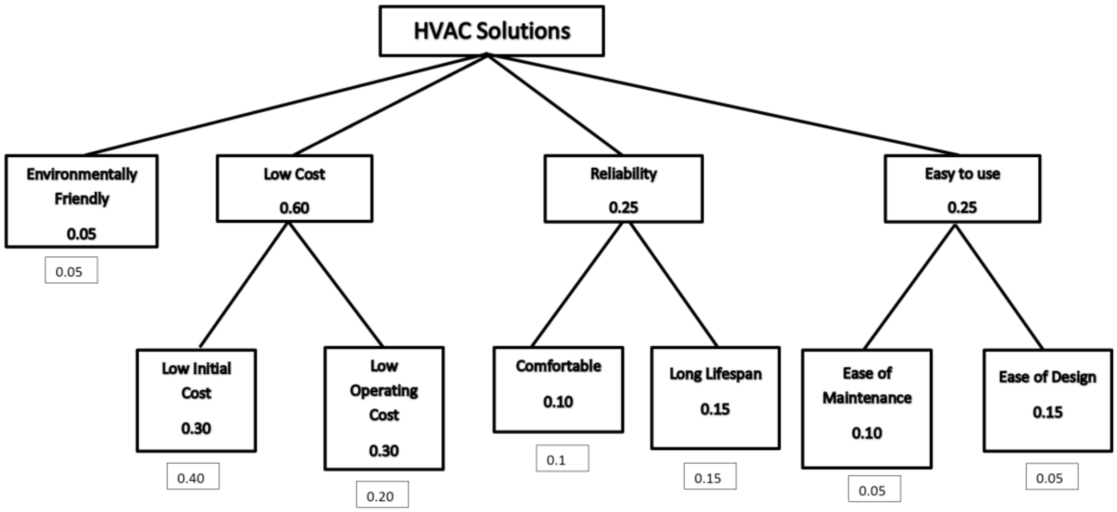


Figure 11: Objective Tree

The evaluation criteria listed in the objective tree in figure 11 could change from project to project, but most will remain the same. The weighting factors for each criteria would change depending on the building owner's needs, priorities, building type, and budget. The weighting factors I chose are assumptions for a building of this size and type. It is important to remember the type of building, which is a sheriff's department in this case. Aesthetics are not nearly as important as budget, but they still want the building to look impressive and presentable to the public, focusing on the outside rather than the inside. In the objective tree and weighted decision matrix for this example, I assumed the building owner has a strict budget for both initial and operating costs, focusing on the ease of the project and operation rather than the environment.

I created the weighted decision matrix in table 7 on Excel. It can be used as a tool to guide decision making between different HVAC solutions. Other sytstems can even be added to new columns on the right. The weighting factors (W) are to be edited based off owner, engineer, or architect preferences for their specific building. The V column under each system is a number I used to rank them based off online research and industry experience. Of course, there are many other factors specific to a situation that can influence this decision, but this can help organize thoughts. When there are too many factors to consider when constructing a new building, it can be overwhelming to prioritize. Seeing the criteria such as low cost, environmentally friendly, and lifespan all spelled out on a weighted decision matrix may aid in the process.

Evaluation Criteria		*Weighting Factor, W*	*Electric VAV*		*Hydronic VAV*		*VRV*	
			V	*VxW*	*V*	*VxW*	*V*	*VxW*
1	*Low Initial Cost*	*0.4*	*4*	*1.6*	*3*	*1.2*	*2*	*0.8*
	Low Operating Cost	*0.2*	*2*	*0.4*	*2*	*0.4*	*5*	*1*
2	*Environmentally Friendly*	*0.05*	*2*	*0.1*	*2*	*0.1*	*5*	*0.25*
3	*Comfortable*	*0.1*	*3*	*0.3*	*3*	*0.3*	*5*	*0.5*
	Long Lifespan	*0.15*	*4*	*0.6*	*4*	*0.6*	*3*	*0.45*
4	*Ease of Maintenance*	*0.05*	*3*	*0.15*	*1*	*0.05*	*5*	*0.25*
	Ease of Design	*0.05*	*3*	*0.15*	*2*	*0.1*	*4*	*0.2*
	Total:	*1*	*Total:*	*3.3*	*Total:*	*2.75*	*Total:*	*3.45*

^ CHANGE THESE WEIGHTING FACTORS (W) DEPENDING ON THE PROJECT, BUDGET, ENGINEER AND OWNER PREFERENCES
must add up to 1

HVAC Solution with Highest Sum:	3.45	VRV

1 = undesirable/fails at criteria
2 = bad at criteria
3 = average
4 = good at criteria
5 = successful/best at that criteria

Table 2: Weighted Decision Matrix

5. Conclusion

5.1 Summary

After a comprehensive energy model was completed for Raleigh County Sheriff's Department, it was determined that the Variable Refrigerant Volume (VRV) system would yield the lowest costs, energy consumption, and carbon footprint for the building. While these factors may be attractive to some building owners, there are other aspects to consider. Initial cost, operating cost, comfort, maintenance, lifespan, environmental impact, and design process were all studied, combining research, the energy model, and knowledge from experience. This project serves as a tool for selecting the "best" HVAC solution, depending on one's needs. While it only focuses on VAV and VRV systems, the same factors and ideas can be applied to other HVAC systems, such as furnaces or constant volume. Energy efficiency, along with operating cost, would vary heavily depending on the location, construction, and building type. An office building, such as the Sheriff department, would have different load demands than a gym or a school. These comparisons should be taken lightly if applied to other buildings; a full energy model would need to be completed to understand the energy loads and yearly operating conditions. The main deliverables from this project include: an energy model, a full design set, a weighted decision matrix, and initial cost estimates.

5.2 Uncertainties

While technology has advanced rapidly since the days of pencil and paper building design, there are still many uncertainties when it comes to modeling a building. Trane's Trace 3D software is some of the most current energy modeling software, so it is as accurate as we can get without spending too much money. There are ten percent safety factors built into the load calculation software used at SBM. Furthermore, the energy use and cost calculations are not meant to be exact and up-to-date estimations. They are simply for comparison purposes; but since each alternate used the same values, this is sufficient.

5.3 Future work

If this project were to be continued, the energy model would be tested with many other variables to get a comprehensive analysis of how these systems respond to changes in location, walls, windows, and building types. It would also be beneficial to get input from other engineers, especially those who manufacture/design the actual VAV/VRV units. They could help choose the weighting factors for the weighted decision matrix, drawing unique conclusions.

5.4 Personal Impact

This project gave me valuable experience in my field, which I will be working for after graduation. I learned how to use Trace 3D and DAIKIN WebXpress, making me an asset to SBM. Designing a VRV system, and researching the benefits, was also beneficial. I had not worked with VRV much prior to this project, and it is a popular system in the field. My biggest takeaways were learning the different aspects of an HVAC solution and how they compare, understanding and enhancing the decision-making process. It was also helpful to work through an entire project with less guidance than I previously received on Co-op. This sense of independence and work ethic will be important when I start my career.

References

[1] *Standard 62.1 Ventilation for Acceptable Indoor Air Quality*, ASHRAE, Atlanta, GA. 2019.

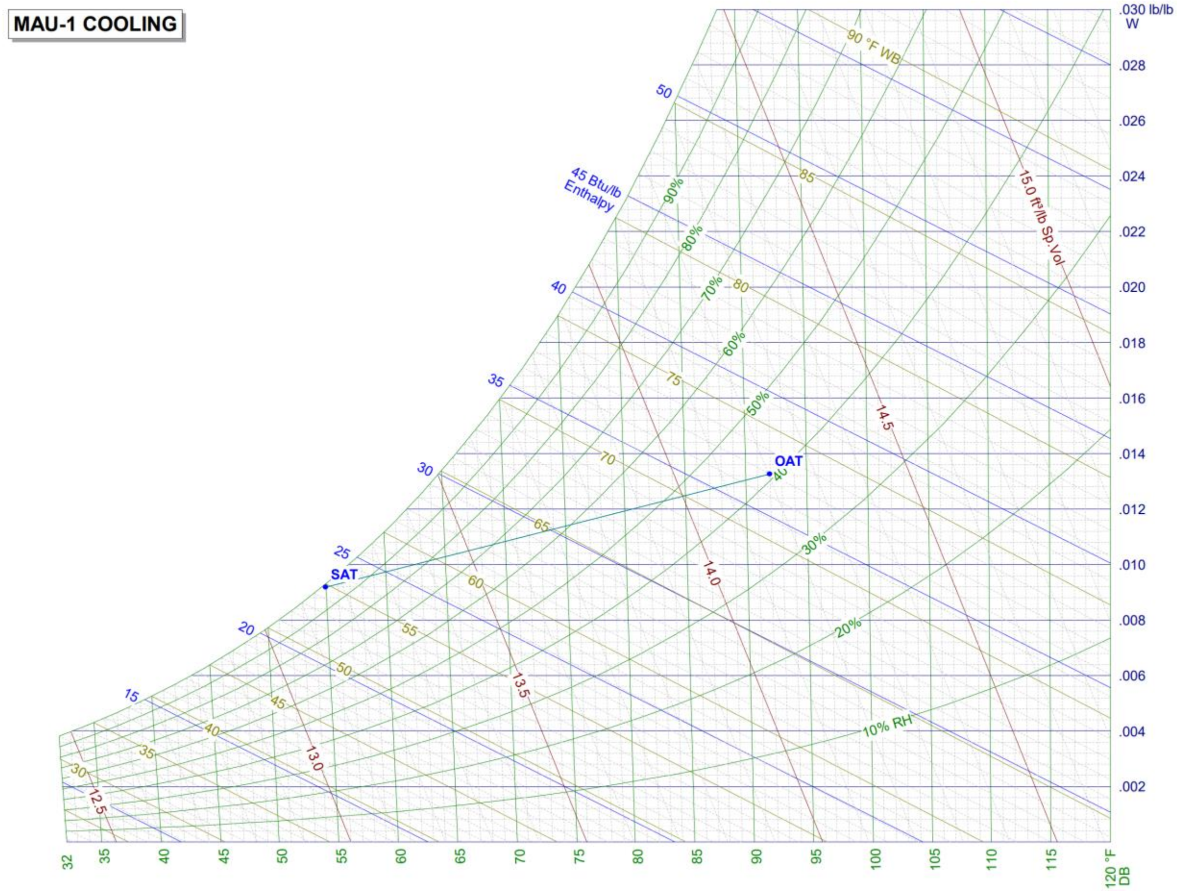
[2] *Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings*, ASHRAE, Atlanta, GA. 2019.

[3] *Application Guide – VAV with Reheat Systems*, DAIKIN, March 2018.

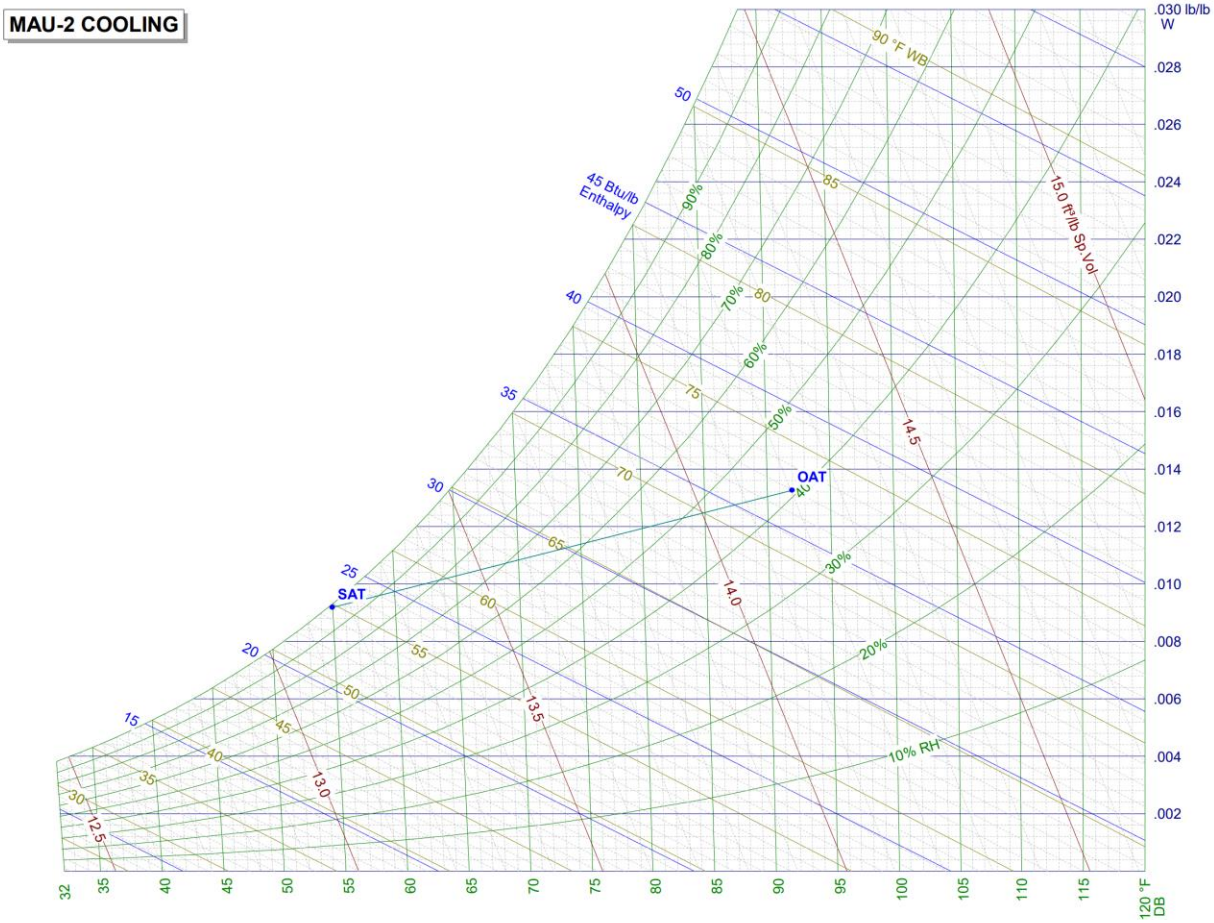
[4] Jankovic, Alex. *Back to basics: VRF systems*, Consulting Specifying Engineer Magazine, 27 September 2016.

[5] Dwyer, Tim. *Maintaining comfort, as well as efficiency, with VRV systems*, CIBSE Journal, January 2015.

Appendices



Appendix 1: MAU-1 Psychrometric Chart



Appendix 2: MAU-2 Psychrometric Chart

MAKEUP AIR UNIT COIL SIZING			
HEATING COIL			
AT FULL FLOW			
SA CFM	2700	from airflow sheet Voz	
OA CFM	2700	from airflow sheet Voz	
RA CFM	0		
		FROM ASHRAE FUNDAMENTALS 2021 IS 14.8 WINTER, WE WILL USE 0 DEG BASED ON REAL WORLD EXPERIENCE	
OA TEMP	0		
RA TEMP	70		
SA TEMP	70		
MAT	0		
HEATING BTU	**204120**		
Output (80%)	163296		
COOLING COIL	**(values come from psychrometric chart) - USUALLY ONLY SEND REP THE OA T AND CFM, SA T AND CFM AND RA, THEY SIZE COIL**		
SA CFM	2700		
OA CFM	2700		
OA db/wb	92	73	FROM ASHRAE FUNDAMENTALS 2021
MAT db/wb	92	73	
SAT db/wb	55	54.8	MUST COOL TO 55 LAT FOR DEHUMIDIFICATION PURPOSES. UNIT LAT WILL BE 70
			NEED HOT GAS REHEAT
OA h	36.69		
SA h	23.17		
Qsensible BTU/hr	**107892**		
Qtotal BTU/hr	**164268**		
Qtotal Tons	13.689	MODEL DPS015 (15 TONS- 2700 CFM)	
		DAIKIN REBEL	

Appendix 3:MAU-1 Cooling Coil Sizing Excel Sheet

MAKEUP AIR UNIT COIL SIZING			
HEATING COIL			
AT FULL FLOW			
SA CFM	2300	from airflow sheet Voz	
OA CFM	2300	from airflow sheet Voz	
RA CFM	0		
		FROM ASHRAE FUNDAMENTALS 2021 IS 14.8 WINTER, WE WILL USE 0 DEG BASED ON REAL WORLD EXPERIENCE	
OA TEMP	0		
RA TEMP	70		
SA TEMP	70		
MAT	0		
HEATING BTU	**173880**		
Output (80%)	139104		
COOLING COIL	**(values come from psychrometric chart) - USUALLY ONLY SEND REP THE OA T AND CFM, SA T AND CFM AND RA, THEY SIZE COIL**		
SA CFM	2300		
OA CFM	2300		
OA db/wb	92	73	FROM ASHRAE FUNDAMENTALS 2021
MAT db/wb	92	73	
SAT db/wb	55	54.8	MUST COOL TO 55 LAT FOR DEHUMIDIFICATION PURPOSES. UNIT LAT WILL BE 70
			NEED HOT GAS REHEAT
OA h	36.69		
SA h	23.17		
Qsensible BTU/hr	**91908**		
Qtotal BTU/hr	**139932**		
Qtotal Tons	11.661	MODEL DPS012 (12 TONS- 2300 CFM)	
		DAIKIN REBEL	

Appendix 4: MAU-2 Cooling Coil Sizing

SCHEESER BUCKLEY MAYFIELD,LLC.

HVAC ESTIMATE OF PROBABLE CONSTRUCTION COSTS IN ENGLISH UNITS

VERSION 02.03.2020

PROJECT NAME:	Raleigh Co	PHASE:	Design Development
PROJECT NUMBER:	19169	REVISION:	
DATE:	07/24/20	NOTES:	
COMPLETED BY:	Knotts		
FILENAME:	https://d.docs.live.net/1dfef269fca31e70/Senior Design Project/STUFF FROM WORK COMPUTER/[19169 DD Estimate Hvac.xlsm]HVAC		

BUILDING PROJECT AREA (SQUARE FEET)	27,300	INDICATE "0" IN COLUMN IF NOT APPLICABLE
PIPE FITTING MULTIPLIER	1.20	INDICATE "1" IN M COLUMN IF MULTIPLIER IS TO BE USED
ESTIMATED CONTRACTOR'S OVERHEAD RATE	10.0%	
ESTIMATED CONTRACTOR'S PROFIT RATE	10.0%	
MAJOR EQUIPMENT ITEM MARK-UP	5.00%	
MAJOR SUBCONTRACTOR MARK-UP	5.00%	
MATERIAL MARKUP	0.0%	
ALLOWANCE FOR UNKNOWN SCOPE	7.00%	
INFLATION FACTOR	0.0%	
PERFORMANCE BOND	YES	INDICATE "YES" IF PERFORMANCE BOND REQUIRED
STATE SALES TAX ON MATERIALS	0.00%	

SUMMARY OF COSTS:

ITEM DESCRIPTION	LABOR COST TOTAL	MATERIAL COST TOTAL	ITEM COST TOTAL
LABOR & MATERIAL SUBTOTALS (subject to Overhead and Profit)	$51,387	$288,327	$339,713
CONTRACTOR'S OVERHEAD SUBTOTAL			$33,971
CONTRACTOR'S PROFIT SUBTOTAL			$33,971
LABOR AND MATERIALS (MAJOR EQUIPMENT)	$0	$0	$0
MAJOR ITEM MARKUP (APPLIED TO MATERIAL ONLY)			$0
LABOR AND MATERIALS (MAJOR SUBCONTRACTORS)	$0	$385,330	$385,330
MAJOR SUBCONTRACTOR MARKUP			$19,267
MATERIAL MARKUP			$0
SUBTOTAL			$812,253
INFLATION			$0
PERFORMANCE BOND			$11,623
STATE SALES TAX ON MATERIALS			$0
ALLOWANCE FOR UNKNOWN SCOPE			$56,858
TOTAL HVAC ESTIMATE			**$880,733**
	TOTAL COST / SQ. FT		**$32**

CODE		ITEM DESCRIPTION	LABOR PER UNIT	MATERIAL PER UNIT	TOTAL	UNITS	M	QUANTITY	TOTAL LABOR	TOTAL MATERIAL	TOTAL
		SPECIFICATION SECTION 237100 VARIABLE FREQUENCY DRIVES									
0338	M	5HP VARIABLE FREQ. DRIVE (ADD $450 FOR BYPASS)	$441.00	$1,072.50	$1,513.50	EA.		1	$441	$1,073	$1,514
		SPECIFICATION SECTION 230593 TESTING, ADJUSTING, AND BALANCING									
0371		AIR BALANCING - UTILTY SET FANS	$420.00	$0.00	$420.00	Ea.		1	$420	$0	$420
0373		AIR BALANCING -ROOF EXHAUST FANS	$280.00	$0.00	$280.00	Ea.		2	$560	$0	$560
0377		AIR BALANCING - PACKAGED A/C UNIT	$350.00	$0.00	$350.00	Ea.		2	$700	$0	$700
0385		AIR BALANCING - VAV TERMINAL UNITS	$84.00	$0.00	$84.00	Ea.		44	$3,696	$0	$3,696
		SPECIFICATION SECTION 233300 AIR DUCT ACCESSORIES									
0616	M	SOUND ATTENUATORS (TOTAL SA CFM)	$11.25	$199.65	$210.90	MCFM		1	$11	$200	$211
		SPECIFICATION SECTION 233416 CENTRIFUGAL HVAC FANS									
0636		EVIDENCE FAN AND FILTER ASSEMBLY	$1,000.00	$12,000.00	$13,000.00	Ea.		1	$1,000	$12,000	$13,000
		SPECIFICATION SECTION 233423 HVAC POWER VENTILATORS									
0649		600 CFM CENT ROOF EXHAUSTER	$190.00	$1,012.00	$1,202.00	Ea.		1	$190	$1,012	$1,202
0651		1450 CFM CENT ROOF EXHAUSTER	$272.00	$2,012.50	$2,284.50	Ea.		1	$272	$2,013	$2,285
		SPECIFICATION SECTION 233600 AIR TERMINAL UNITS									
0671		VAV TERM. UNIT W/COIL (AVG)(digital)	$250.00	$1,140.00	$1,390.00	Ea.		44	$11,000	$50,160	$61,160
		SPECIFICATION SECTION 233713 DIFFUSERS, REGISTERS, AND GRILLES									
0680	M	SUPPLY DIFFUSERS CEILING (AVG)	$41.50	$38.50	$80.00	Ea.		101	$4,192	$3,889	$8,080
0682	M	RETURN REGISTERS CEILING (AVG)	$55.50	$44.00	$99.50	Ea.		65	$3,608	$2,860	$6,468
0684		EXHAUST REGISTERS CEILING (AVG)	$23.50	$50.50	$74.00	Ea.		14	$329	$707	$1,036
		SPECIFICATION SECTION 235100 BREECHINGS, CHIMNEYS, AND STACKS									
0695		6" TYPE B DBLE WALL GALV GAS VENT	$14.95	$12.65	$27.60	V.L.F.		30	$449	$380	$828
		SPECIFICATION SECTION 237413 PACKAGED, OUTDOOR, CENTRAL-STATION AIR HANDLING UNITS									
1065		ROOFTOP UNITS	$5,250.00	$95,000.00	$100,250.00	Ea.		2	$10,500	$190,000	$200,500
		SPECIFICATION SECTION 238126 SPLIT-SYSTEM AIR-CONDITIONING UNITS									
1125		3 TON SPLIT DUCTLESS SYSTEM CLG ONLY	$785.00	$2,703.75	$3,488.75	Ea.		2	$1,570	$5,408	$6,978
1127		1-1/2 TON SPLIT DUCTLESS SYSTEM CLG/HTG	$630.00	$2,100.00	$2,730.00	Ea.		2	$1,260	$4,200	$5,460
		SPECIFICATION SECTION 238239.19 ELECTRIC WALL, CABINET, AND UNIT HEATERS									
1322		ELECTRIC BASEBOARD HEATERS	$112.00	$116.00	$228.00	kW		20	$2,240	$2,320	$4,560
1324		3KW CABINET UNIT HEATER	$112.00	$2,325.00	$2,437.00	Ea.		4	$448	$9,300	$9,748
1341		3000 WATT ELECTRIC WALL HEATER	$164.00	$467.50	$631.50	Ea.		5	$820	$2,338	$3,158
1343		3KW HORIZ ELECTRIC UNIT HEATER	$82.00	$470.00	$552.00	Ea.		1	$82	$470	$552
		GENERAL ITEMS									
1381		HVAC GENERAL CONDITIONS	$5,000.00	$0.00	$5,000.00	LOT		1	$5,000	$0	$5,000
1385		RIGGING	$1,300.00	$0.00	$1,300.00	DAY		2	$2,600	$0	$2,600
3001		SHEET METAL (DUCTWORK)	$0.00	$235,330.06	$235,330.06	LOT		1	$0	$235,330	$235,330
3002		TEMPERATURE CONTROLS	$0.00	$150,000.00	$150,000.00	LOT		1	$0	$150,000	$150,000
3004		RIGGING	$0.00	$0.00	$0.00	LOT		1	$0	$0	$0

Appendix 5: HVAC Cost Estimate for Original Design

SCHEESER*BUCKLEY*MAYFIELD,LLC.

DUCTWORK PROBABLE COST OF CONSTRUCTION PROGRAM

GALVANIZED

VERSION 02.26.20

PROJECT NAME:	Raleigh Co	FILENAME:	https://d.docs.live.net/1dfef269fca31e70/Senior Design Project/S
PROJECT NUMBER:	19169	REVISION:	
DATE:		NOTES:	
COMPLETED BY:	Knotts		

ESTIMATE TOTALS

DUCTWORK		LBS	LABOR	MATERIAL	OVERHEAD	PROFIT	SUB-LABOR	SUB-MATERIAL	TOTAL
	1/2" WG	0.0	$0	$0	$0	$0	$0	$0	$0
	2" WG	4031.8	$47,011	$3,770	$7,617	$5,078	$52,704	$10,117	$62,822
	4" WG	8135.1	$94,855	$7,606	$15,369	$10,246	$106,343	$20,414	$126,757
	6" WG	0.0	$0	$0	$0	$0	$0	$0	$0
	10" WG	0.0	$0	$0	$0	$0	$0	$0	$0
	TOTALS	12166.9	$141,866	$11,376	$22,986	$15,324	$159,047	$30,531	$189,578

INSULATION		SQ. FEET	LABOR	MATERIAL	OVERHEAD	PROFIT	SUB-LABOR	SUB-MATERIAL	TOTAL
	ALL	8115.6	$25,442	$11,159	$5,490	$3,660	$30,018	$15,734	$45,752

INPUT

DUCT WIDTH/DIAM. (IN.)	DUCT HEIGHT (IN.)	INSULATION CODE	INSULATION TYPE	CLASS (IN. W.G.)	LINEAL FEET	DUCT PERIMETER (IN.)	DUCT GAUGE	DUCT JOINT	DUCT LBS.	INSULATION SQ. FEET
80	20	0	NONE	4	10	200.0	16	STANDARD JOINT	442.7	0.0
8	8	0	NONE	2	25	32.0	26	STANDARD JOINT	60.4	0.0
8	10	0	NONE	2	10	36.0	26	STANDARD JOINT	27.2	0.0
10	8	0	NONE	2	75	36.0	26	STANDARD JOINT	203.9	0.0
12	10	0	NONE	2	60	44.0	26	STANDARD JOINT	199.3	0.0
12	12	0	NONE	2	5	48.0	26	STANDARD JOINT	18.1	0.0
14	10	0	NONE	2	20	48.0	26	STANDARD JOINT	72.5	0.0
18	10	0	NONE	2	55	56.0	26	STANDARD JOINT	232.5	0.0
21		0	NONE	2	5	66.0	26	STANDARD JOINT	24.9	0.0
22	12	0	NONE	2	10	68.0	26	STANDARD JOINT	51.3	0.0
24	12	0	NONE	2	30	72.0	26	STANDARD JOINT	163.1	0.0
6		4	2" DUCTWRAP	2	125	18.8	26	STANDARD JOINT	177.9	196.3
8		4	2" DUCTWRAP	2	140	25.1	26	STANDARD JOINT	265.7	293.2
10	8	4	2" DUCTWRAP	2	160	36.0	26	STANDARD JOINT	434.9	480.0
10	10	4	2" DUCTWRAP	2	50	40.0	26	STANDARD JOINT	151.0	166.7
10		4	2" DUCTWRAP	2	115	31.4	26	STANDARD JOINT	272.8	301.1
12	8	4	2" DUCTWRAP	2	15	40.0	26	STANDARD JOINT	45.3	50.0
12	10	4	2" DUCTWRAP	2	50	44.0	26	STANDARD JOINT	166.1	183.3
12		4	2" DUCTWRAP	2	75	37.7	26	STANDARD JOINT	213.5	235.6
14	10	4	2" DUCTWRAP	2	15	48.0	26	STANDARD JOINT	54.4	60.0
14	12	4	2" DUCTWRAP	2	65	52.0	26	STANDARD JOINT	255.2	281.7
18	12	4	2" DUCTWRAP	2	10	60.0	26	STANDARD JOINT	45.3	50.0
20	12	4	2" DUCTWRAP	2	10	64.0	26	STANDARD JOINT	48.3	53.3
20	14	4	2" DUCTWRAP	2	15	68.0	26	STANDARD JOINT	77.0	85.0
20		4	2" DUCTWRAP	2	140	62.8	26	STANDARD JOINT	664.1	733.0
24	10	4	2" DUCTWRAP	2	5	68.0	26	STANDARD JOINT	25.7	28.3
24	12	4	2" DUCTWRAP	2	15	72.0	26	STANDARD JOINT	81.5	90.0
			NONE			0.0	0	STANDARD JOINT	0.0	0.0
6	6	4	2" DUCTWRAP	4	10	24.0	24	STANDARD JOINT	23.1	20.0
6		4	2" DUCTWRAP	4	60	18.8	24	STANDARD JOINT	109.0	94.2
8	8	4	2" DUCTWRAP	4	35	32.0	24	STANDARD JOINT	107.9	93.3
8		4	2" DUCTWRAP	4	60	25.1	24	STANDARD JOINT	145.3	125.7
10	8	4	2" DUCTWRAP	4	60	36.0	24	STANDARD JOINT	208.1	180.0
10	10	4	2" DUCTWRAP	4	20	40.0	24	STANDARD JOINT	77.1	66.7
10		4	2" DUCTWRAP	4	5	31.4	24	STANDARD JOINT	15.1	13.1
12	8	4	2" DUCTWRAP	4	5	40.0	24	STANDARD JOINT	19.3	16.7
12	10	4	2" DUCTWRAP	4	40	44.0	24	STANDARD JOINT	169.5	146.7
14	10	4	2" DUCTWRAP	4	20	48.0	24	STANDARD JOINT	92.5	80.0
14	12	4	2" DUCTWRAP	4	45	52.0	24	STANDARD JOINT	225.4	195.0
14	81	4	2" DUCTWRAP	4	5	190.0	24	STANDARD JOINT	91.5	79.2
14		4	2" DUCTWRAP	4	5	44.0	24	STANDARD JOINT	21.2	18.3
16	10	4	2" DUCTWRAP	4	15	52.0	24	STANDARD JOINT	75.1	65.0
16	12	4	2" DUCTWRAP	4	95	56.0	24	STANDARD JOINT	512.5	443.3
16	14	4	2" DUCTWRAP	4	5	60.0	24	STANDARD JOINT	28.9	25.0
18	12	4	2" DUCTWRAP	4	20	60.0	24	STANDARD JOINT	115.6	100.0
20	12	4	2" DUCTWRAP	4	15	64.0	24	STANDARD JOINT	92.5	80.0
21	8	4	2" DUCTWRAP	4	15	58.0	24	STANDARD JOINT	83.8	72.5

DUCT WIDTH/DIAM. (IN.)	DUCT HEIGHT (IN.)	INSULATION CODE	INSULATION TYPE	CLASS (IN. W.G.)	LINEAL FEET	DUCT PERIMETER (IN.)	DUCT GAUGE	DUCT JOINT	DUCT LBS.	INSULATION SQ. FEET
24	12	4	2" DUCTWRAP	4	95	72.0	22	STANDARD JOINT	801.4	570.0
28	12	4	2" DUCTWRAP	4	25	80.0	22	STANDARD JOINT	234.3	166.7
28	81	4	2" DUCTWRAP	4	5	218.0	22	STANDARD JOINT	127.7	90.8
30	12	4	2" DUCTWRAP	4	25	84.0	22	STANDARD JOINT	246.1	175.0
30	80	4	2" DUCTWRAP	4	5	220.0	22	STANDARD JOINT	128.9	91.7
31	12	4	2" DUCTWRAP	4	15	86.0	22	STANDARD JOINT	151.1	107.5
34	12	4	2" DUCTWRAP	4	5	92.0	20	STANDARD JOINT	63.5	38.3
36	12	4	2" DUCTWRAP	4	15	96.0	20	STANDARD JOINT	198.7	120.0
38	12	4	2" DUCTWRAP	4	10	100.0	20	STANDARD JOINT	138.0	83.3
40	14	4	2" DUCTWRAP	4	5	108.0	20	STANDARD JOINT	74.5	45.0
41	14	4	2" DUCTWRAP	4	5	110.0	20	STANDARD JOINT	75.9	45.8
42	12	4	2" DUCTWRAP	4	5	108.0	18	STANDARD JOINT	97.0	45.0
46	12	4	2" DUCTWRAP	4	30	116.0	18	STANDARD JOINT	625.2	290.0
48	12	4	2" DUCTWRAP	4	5	120.0	18	STANDARD JOINT	107.8	50.0
50	12	4	2" DUCTWRAP	4	10	124.0	18	STANDARD JOINT	222.8	103.3
58	14	4	2" DUCTWRAP	4	30	144.0	18	STANDARD JOINT	776.2	360.0
70	18	4	2" DUCTWRAP	4	15	176.0	16	STANDARD JOINT	584.3	220.0
74	14	4	2" DUCTWRAP	4	5	176.0	16	STANDARD JOINT	194.8	73.3
80	12	4	2" DUCTWRAP	4	5	184.0	16	STANDARD JOINT	203.6	76.7
80	18	4	2" DUCTWRAP	4	5	196.0	16	STANDARD JOINT	216.9	81.7
81	14	4	2" DUCTWRAP	4	5	190.0	16	STANDARD JOINT	210.3	79.2

Appendix 6: Ductwork and Insulation Cost Estimate for Original Design

SCHEESER BUCKLEY MAYFIELD,LLC.

HVAC ESTIMATE OF PROBABLE CONSTRUCTION COSTS IN ENGLISH UNITS

VERSION 02.03.2020

PROJECT NAME:	Raleigh County	PHASE:	
PROJECT NUMBER:	-	REVISION:	
DATE:	03/01/22	NOTES:	
COMPLETED BY:	Erica Ferguson		
FILENAME:	https://d.docs.live.net/1dfef269fca31e70/Senior Design Project/STUFF FROM WORK COMPUTER/flash drive/VRF/[hvac estimate VRF.xlsm]HVAC		

BUILDING PROJECT AREA (SQUARE FEET)	27,300	INDICATE "0" IN COLUMN IF NOT APPLICABLE
PIPE FITTING MULTIPLIER	1.20	INDICATE "1" IN M COLUMN IF MULTIPLIER IS TO BE USED
ESTIMATED CONTRACTOR'S OVERHEAD RATE	10.0%	
ESTIMATED CONTRACTOR'S PROFIT RATE	10.0%	
MAJOR EQUIPMENT ITEM MARK-UP	5.00%	
MAJOR SUBCONTRACTOR MARK-UP	5.00%	
MATERIAL MARKUP	0.0%	
ALLOWANCE FOR UNKNOWN SCOPE	7.00%	
INFLATION FACTOR	0.0%	
PERFORMANCE BOND	YES	INDICATE "YES" IF PERFORMANCE BOND REQUIRED
STATE SALES TAX ON MATERIALS	0.00%	

SUMMARY OF COSTS:

Scheeser Buckley Mayfield

ITEM DESCRIPTION	LABOR COST TOTAL	MATERIAL COST TOTAL	ITEM COST TOTAL
LABOR & MATERIAL SUBTOTALS (subject to Overhead and Profit)	$154,492	$513,186	$667,678
CONTRACTOR'S OVERHEAD SUBTOTAL			$66,768
CONTRACTOR'S PROFIT SUBTOTAL			$66,768
LABOR AND MATERIALS (MAJOR EQUIPMENT)	$0	$0	$0
MAJOR ITEM MARKUP (APPLIED TO MATERIAL ONLY)			$0
LABOR AND MATERIALS (MAJOR SUBCONTRACTORS)	$0	$385,330	$385,330
MAJOR SUBCONTRACTOR MARKUP			$19,267
MATERIAL MARKUP			$0
SUBTOTAL			$1,205,810
INFLATION			$0
PERFORMANCE BOND			$15,558
STATE SALES TAX ON MATERIALS			$0
ALLOWANCE FOR UNKNOWN SCOPE			$84,407
TOTAL HVAC ESTIMATE			**$1,305,774**
TOTAL COST / SQ. FT			**$48**

CODE		ITEM DESCRIPTION	LABOR PER UNIT	MATERIAL PER UNIT	TOTAL	UNITS	M	QUANTITY	TOTAL LABOR	TOTAL MATERIAL	TOTAL
		HVAC PIPING									
0001		VRV REFRIGERANT PIPING ($/SQUARE FOOT)	$3.00	$3.00	$6.00	L.F.		27000	$81,000	$81,000	$162,000
		SPECIFICATION SECTION 237100 VARIABLE FREQUENCY DRIVES									
0338	M	5HP VARIABLE FREQ. DRIVE (ADD $450 FOR BYPASS)	$441.00	$1,072.50	$1,513.50	EA.		1	$441	$1,073	$1,514
		SPECIFICATION SECTION 230593 TESTING, ADJUSTING, AND BALANCING									
0371		AIR BALANCING - UTILTY SET FANS	$420.00	$0.00	$420.00	Ea.		1	$420	$0	$420
0378		AIR BALANCING - TYPICAL DIFF, REG, OR GRILLE (AVG HEIGHT	$84.00	$0.00	$84.00	Ea.		86	$7,224	$0	$7,224
		SPECIFICATION SECTION 233416 CENTRIFUGAL HVAC FANS									
0636		EVIDENCE FAN AND FILTER ASSEMBLY	$1,000.00	$12,000.00	$13,000.00	Ea.		1	$1,000	$12,000	$13,000
		SPECIFICATION SECTION 233423 HVAC POWER VENTILATORS									
0649		600 CFM CENT ROOF EXHAUSTER	$190.00	$1,012.00	$1,202.00	Ea.		1	$190	$1,012	$1,202
0651		1450 CFM CENT ROOF EXHAUSTER	$272.00	$2,012.50	$2,284.50	Ea.		1	$272	$2,013	$2,285
		SPECIFICATION SECTION 233713 DIFFUSERS, REGISTERS, AND GRILLES									
0680	M	SUPPLY DIFFUSERS CEILING (AVG)	$41.50	$38.50	$80.00	Ea.		86	$3,569	$3,311	$6,880
0684		EXHAUST REGISTERS CEILING (AVG)	$23.50	$50.50	$74.00	Ea.		14	$329	$707	$1,036
		SPECIFICATION SECTION 235100 BREECHINGS, CHIMNEYS, AND STACKS									
0695		6" TYPE B DBLE WALL GALV GAS VENT	$14.95	$12.65	$27.60	V.L.F.		30	$449	$380	$828
		SPECIFICATION SECTION 237423 MAKEUP AIR HANDLING UNITS									
1073		1750 MBH ROOFTOP MAKE-UP AIR UNIT	$640.00	$33,990.00	$34,630.00	Ea.		2	$1,280	$67,980	$69,260
		SPECIFICATION SECTION 238126 SPLIT-SYSTEM AIR-CONDITIONING UNITS									
1125		3 TON SPLIT DUCTLESS SYSTEM CLG ONLY	$785.00	$2,703.75	$3,488.75	Ea.		2	$1,570	$5,408	$6,978
1127		1-1/2 TON SPLIT DUCTLESS SYSTEM CLG/HTG	$630.00	$2,100.00	$2,730.00	Ea.		2	$1,260	$4,200	$5,460
		SPECIFICATION SECTION 238219.11 VRV SYSTEMS									
1223		0.6 TON CEILING CONCEALED DUCTED VRV	$365.00	$1,725.00	$2,090.00	Ea.		6	$2,190	$10,350	$12,540
1224		0.75 TON CEILING CONCEALED DUCTED VRV	$365.00	$1,775.00	$2,140.00	Ea.		1	$365	$1,775	$2,140
1225		1 TON CEILING CONCEALED DUCTED VRV	$365.00	$1,875.00	$2,240.00	Ea.		1	$365	$1,875	$2,240
1226		1.5 TON CEILING CONCEALED DUCTED VRV	$365.00	$1,950.00	$2,315.00	Ea.		2	$730	$3,900	$4,630
1227		2 TON CEILING CONCEALED DUCTED VRV	$372.30	$2,415.00	$2,787.30	Ea.		1	$372	$2,415	$2,787
1228		2.5 TON CEILING CONCEALED DUCTED VRV	$372.30	$2,782.50	$3,154.80	Ea.		1	$372	$2,783	$3,155
1229		3 TON CEILING CONCEALED DUCTED VRV	$372.30	$2,966.25	$3,338.55	Ea.		1	$372	$2,966	$3,339
1230		4 TON CEILING CONCEALED DUCTED VRV	$418.20	$2,808.75	$3,226.95	Ea.		3	$1,255	$8,426	$9,681
1231		6 TON CEILING CONCEALED DUCTED VRV	$464.10	$5,145.00	$5,609.10	Ea.		3	$1,392	$15,435	$16,827
1232		0.75 TON CEILING CASSETTE DUCTLESS VRV	$273.00	$2,050.00	$2,323.00	Ea.		19	$5,187	$38,950	$44,137
1233		1 TON CEILING CASSETTE DUCTLESS VRV	$320.00	$2,175.00	$2,495.00	Ea.		6	$1,920	$13,050	$14,970
1234		1.5 TON CEILING CASSETTE DUCTLESS VRV	$340.00	$2,250.00	$2,590.00	Ea.		1	$340	$2,250	$2,590
1250		THERMOSTAT	$413.10	$425.25	$838.35	Ea.		45	$18,590	$19,136	$37,726
1258		HEAT PUMP 8 TONS COOLING UP TO 17 ZONES	$739.50	$31,710.00	$32,449.50	Ea.		2	$1,479	$63,420	$64,899
1259		8 TON CONDENSING UNIT ISOLATION RAILS	$372.30	$1,128.75	$1,501.05	Pair		2	$745	$2,258	$3,002
1260		HEAT PUMP 15 TONS COOLING UP TO 33 ZONES	$963.90	$40,530.00	$41,493.90	Ea.		2	$1,928	$81,060	$82,988
1261		15 TON CONDENSING UNIT ISOLATION RAILS	$372.30	$1,312.50	$1,684.80	Pair		2	$745	$2,625	$3,370
1262	M	MITSUBISHI CMB-1108 BC (MAIN) - 8 PORT	$455.00	$3,800.00	$4,255.00	Ea.		12	$5,460	$45,600	$51,060
		SPECIFICATION SECTION 238239.19 ELECTRIC WALL, CABINET, AND UNIT HEATERS									
1322		ELECTRIC BASEBOARD HEATERS	$112.00	$116.00	$228.00	kW		20	$2,240	$2,320	$4,560
1324		3KW CABINET UNIT HEATER	$112.00	$2,325.00	$2,437.00	Ea.		4	$448	$9,300	$9,748
1341		3000 WATT ELECTRIC WALL HEATER	$164.00	$467.50	$631.50	Ea.		8	$1,312	$3,740	$5,052
1343		3KW HORIZ ELECTRIC UNIT HEATER	$82.00	$470.00	$552.00	Ea.		1	$82	$470	$552
		GENERAL ITEMS									
1381		HVAC GENERAL CONDITIONS	$5,000.00	$0.00	$5,000.00	LOT		1	$5,000	$0	$5,000
1385		RIGGING	$1,300.00	$0.00	$1,300.00	DAY		2	$2,600	$0	$2,600
3001		SHEET METAL (DUCTWORK)	$0.00	$235,330.06	$235,330.06	LOT		1	$0	$235,330	$235,330
3002		TEMPERATURE CONTROLS	$0.00	$150,000.00	$150,000.00	LOT		1	$0	$150,000	$150,000
3004		RIGGING	$0.00	$0.00	$0.00	LOT		1	$0	$0	$0

Appendix 7: HVAC Cost Estimate for VRV Design

SCHEESER*BUCKLEY*MAYFIELD,LLC.

DUCTWORK PROBABLE COST OF CONSTRUCTION PROGRAM

GALVANIZED

VERSION 02.26.20

PROJECT NAME:	**Raleigh County Sheriff Dept**	FILENAME:	https://d.docs.live.net/1dfef269fca31e70/Senior Design Project/S
PROJECT NUMBER:	-	REVISION:	
DATE:	**3/1/2022**	NOTES:	
COMPLETED BY:	**Erica Ferguson**		

ESTIMATE TOTALS

DUCTWORK		LBS	LABOR	MATERIAL	OVERHEAD	PROFIT	SUB-LABOR	SUB-MATERIAL	TOTAL
	1/2" WG	0.0	$0	$0	$0	$0	$0	$0	$0
	2" WG	5708.2	$66,558	$5,337	$10,784	$7,189	$74,618	$14,324	$88,943
	4" WG	253.1	$2,951	$237	$478	$319	$3,308	$635	$3,943
	6" WG	117.1	$1,365	$109	$221	$147	$1,530	$294	$1,824
	10" WG	0.0	$0	$0	$0	$0	$0	$0	$0
	TOTALS	6078.3	$70,874	$5,683	$11,484	$7,656	$79,457	$15,253	$94,710

INSULATION		SQ. FEET	LABOR	MATERIAL	OVERHEAD	PROFIT	SUB-LABOR	SUB-MATERIAL	TOTAL
	ALL	5342.6	$16,172	$7,231	$3,510	$2,340	$19,098	$10,156	$29,254

INPUT

DUCT WIDTH/DIAM. (IN.)	DUCT HEIGHT (IN.)	INSULATION CODE	INSULATION TYPE	CLASS (IN. W.G.)	LINEAL FEET	DUCT PERIMETER (IN.)	DUCT GAUGE	DUCT JOINT	DUCT LBS.	INSULATION SQ. FEET
6		0	NONE	2	11	18.8	26	STANDARD JOINT	15.7	0.0
8	8	0	NONE	2	13	32.0	26	STANDARD JOINT	31.4	0.0
8	10	0	NONE	2	0.5	36.0	26	STANDARD JOINT	1.4	0.0
10	8	0	NONE	2	51	36.0	26	STANDARD JOINT	138.6	0.0
10	10	0	NONE	2	18	40.0	26	STANDARD JOINT	54.4	0.0
12	10	0	NONE	2	36	44.0	26	STANDARD JOINT	119.6	0.0
12	12	0	NONE	2	2	48.0	26	STANDARD JOINT	7.2	0.0
14	10	0	NONE	2	20	48.0	26	STANDARD JOINT	72.5	0.0
14	12	0	NONE	2	12	52.0	26	STANDARD JOINT	47.1	0.0
14		0	NONE	2	12	44.0	26	STANDARD JOINT	39.8	0.0
18	10	0	NONE	2	52	56.0	26	STANDARD JOINT	219.9	0.0
18		0	NONE	6	13	56.5	22	STANDARD JOINT	86.1	0.0
21		0	NONE	6	4	66.0	22	STANDARD JOINT	30.9	0.0
22	12	0	NONE	2	8	68.0	26	STANDARD JOINT	41.1	0.0
24	12	0	NONE	4	30	72.0	22	STANDARD JOINT	253.1	0.0
						0.0	0	STANDARD JOINT	0.0	0.0
8	6	2	1" DUCTLINER	2	2	28.0	26	STANDARD JOINT	4.2	4.7
8	8	2	1" DUCTLINER	2	13	32.0	26	STANDARD JOINT	31.4	34.7
10	8	2	1" DUCTLINER	2	2	36.0	26	STANDARD JOINT	5.4	6.0
10	10	2	1" DUCTLINER	2	6	40.0	26	STANDARD JOINT	18.1	20.0
12	10	2	1" DUCTLINER	2	6	44.0	26	STANDARD JOINT	19.9	22.0
14	10	2	1" DUCTLINER	2	7	48.0	26	STANDARD JOINT	25.4	28.0
16	12	2	1" DUCTLINER	2	2	56.0	26	STANDARD JOINT	8.5	9.3
20	12	2	1" DUCTLINER	2	9	64.0	26	STANDARD JOINT	43.5	48.0
20	14	2	1" DUCTLINER	2	13	68.0	26	STANDARD JOINT	66.7	73.7
60	20	2	1" DUCTLINER	2	4	160.0	18	STANDARD JOINT	115.0	53.3
						0.0	0	STANDARD JOINT	0.0	0.0
6	4	4	2" DUCTWRAP	2	110	20.0	26	STANDARD JOINT	166.1	183.3
6	6	4	2" DUCTWRAP	2	384	24.0	26	STANDARD JOINT	695.8	768.0
6	8	4	2" DUCTWRAP	2	8	28.0	26	STANDARD JOINT	16.9	18.7
6		4	2" DUCTWRAP	2	20	18.8	26	STANDARD JOINT	28.5	31.4
8	6	4	2" DUCTWRAP	2	105	28.0	26	STANDARD JOINT	222.0	245.0
8	8	4	2" DUCTWRAP	2	86	32.0	26	STANDARD JOINT	207.8	229.3
8		4	2" DUCTWRAP	2	53	25.1	26	STANDARD JOINT	100.6	111.0
10	5	4	2" DUCTWRAP	2	2	30.0	26	STANDARD JOINT	4.5	5.0
10	8	4	2" DUCTWRAP	2	175	36.0	26	STANDARD JOINT	475.7	525.0
10	10	4	2" DUCTWRAP	2	52	40.0	26	STANDARD JOINT	157.0	173.3
10		4	2" DUCTWRAP	2	111	31.4	26	STANDARD JOINT	263.3	290.6
12	10	4	2" DUCTWRAP	2	26	44.0	26	STANDARD JOINT	86.4	95.3
12	12	4	2" DUCTWRAP	2	40	48.0	26	STANDARD JOINT	145.0	160.0
14	10	4	2" DUCTWRAP	2	9	48.0	26	STANDARD JOINT	32.6	36.0
14	12	4	2" DUCTWRAP	2	78	52.0	26	STANDARD JOINT	306.2	338.0
14	14	4	2" DUCTWRAP	2	30	56.0	26	STANDARD JOINT	126.8	140.0
14	16	4	2" DUCTWRAP	2	2	60.0	26	STANDARD JOINT	9.1	10.0
16	10	4	2" DUCTWRAP	2	11	52.0	26	STANDARD JOINT	43.2	47.7
16	12	4	2" DUCTWRAP	2	61	56.0	26	STANDARD JOINT	257.9	284.7
16	14	4	2" DUCTWRAP	2	33	60.0	26	STANDARD JOINT	149.5	165.0
18	12	4	2" DUCTWRAP	2	29	60.0	26	STANDARD JOINT	131.4	145.0
18	14	4	2" DUCTWRAP	2	10	64.0	26	STANDARD JOINT	48.3	53.3
20	6	4	2" DUCTWRAP	2	16	52.0	26	STANDARD JOINT	62.8	69.3
20		4	2" DUCTWRAP	10	34	62.8	20	STANDARD JOINT	294.8	178.0
20	16	4	2" DUCTWRAP	2	121	72.0	26	STANDARD JOINT	657.8	726.0
24	30	4	2" DUCTWRAP	2	6	108.0	26	STANDARD JOINT	48.9	54.0
24		4	2" DUCTWRAP	2	14	75.4	26	STANDARD JOINT	79.7	88.0
30	20	4	2" DUCTWRAP	2	6	100.0	24	STANDARD JOINT	57.8	50.0

Appendix 8: Ductwork and Insulation Cost Estimate for VRV Design

VARIABLE REFRIGERANT VOLUME - INDOOR UNIT SCHEDULE

TAG	ROOM	BASIS OF DESIGN (DAIKIN)	NOMINAL TONNAGE	TYPE	CONNECTED TO:		SUPPLY FAN	COOLING CAPACITY				HEATING CAPACITY	
					CONDENSING UNIT	ZONE CHANGEOVER DEVICE	AIR FLOW RATE cfm	TOTAL BTU/h	SENSIBLE BTU/h	ENTERING AIR °F DB	ENTERING AIR °F WB	TOTAL BTU/h	ENTERING AIR °Fdb
ID-1	Officer Work Stations	FXZQ12TAVJU	1.0	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	353	10,261	7,078	75.0	62.6	13,990	68.0
ID-2	Interview Room	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-3	Processing Rm + Intake	FXZQ07TAVJU	0.6	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	307	6,495	5,210	75.0	62.6	8,872	68.0
ID-4	K-9 Officer Rm + Sallyport	FXZQ07TAVJU	0.6	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	307	6,495	5,210	75.0	62.6	8,872	68.0
ID-13	Armory + Uniform Storage	FXSQ05TAVJU	0.5	MSP Concealed Ducted Unit	OD-1	Yes	281	5,146	4,403	75.0	62.6	6,790	68.0
ID-6	Drugs, Guns, Money Storage	FXSQ07TAVJU	0.6	MSP Concealed Ducted Unit	OD-1	Yes	281	6,546	5,107	75.0	62.6	8,872	68.0
ID-7	Evidence Storage Rm	FXSQ12TAVJU	1.0	MSP Concealed Ducted Unit	OD-1	Yes	335	10,277	8,563	75.0	62.6	13,990	68.0
ID-8	Evidence Lieut. Office	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-9	Bunk Room	FXZQ09TAVJU	0.8	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	317	8,037	5,899	75.0	62.6	10,919	68.0
ID-5	Officer Evidence Processing	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-10	Computer Rooms	FXSQ07TAVJU	0.6	MSP Concealed Ducted Unit	OD-1	Yes	281	6,546	5,107	75.0	62.6	8,872	68.0
ID-11	Womens Lockers + RR	FXZQ07TAVJU	0.6	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	307	6,495	5,210	75.0	62.6	8,872	68.0
ID-12	Mens Locker + RR	FXZQ12TAVJU	1.0	4-Way Discharge Ceiling Cassette (2' x 2')	OD-1	Yes	353	10,261	7,078	75.0	62.6	13,990	68.0
ID-14	Road Patrol Lieut 152	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD 2	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-15	Road Patrol Lieut 151	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD 2	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-16	Road Patrol Lieut 150	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD 2	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-17	Patrol Room	FXMQ72MVJU	6.0	Concealed Ducted (Medium Static)	OD 2	Yes	2,048	60,784	48,766	75.0	62.6	84,000	68.0
ID 43	Patrol Room	FXMQ72MVJU	6.0	Concealed Ducted (Medium Static)	OD 2	Yes	2,048	60,784	48,766	75.0	62.6	84,000	68.0
ID-18	Fitness Training	FXSQ54TAVJU	4.5	MSP Concealed Ducted Unit	OD 2	Yes	1,377	46,821	34,574	75.0	62.6	62,442	68.0
ID-19	Phys Tactics, Training, Gear	FXSQ05TAVJU	0.5	MSP Concealed Ducted Unit	OD 2	Yes	281	5,146	4,403	75.0	62.6	6,790	68.0
ID-20	Records Room	FXSQ07TAVJU	0.6	MSP Concealed Ducted Unit	OD 2	Yes	281	6,546	5,107	75.0	62.6	8,872	68.0
ID-21	Clerk Counter + Corridor	FXSQ18TAVJU	1.5	MSP Concealed Ducted Unit	OD 2	Yes	600	15,456	12,178	75.0	62.6	20,814	68.0
ID-22	Chief Detective Office	FXZQ12TAVJU	1.0	4-Way Discharge Ceiling Cassette (2' x 2')	OD 2	Yes	353	10,261	7,078	75.0	62.6	13,990	68.0
ID-25	Interview Room 138	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD 2	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-26	Interview Room 136	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD 2	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-27	Admin Assistant	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD 2	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-34	Offices 125,126,127	FXSQ15TAVJU	1.3	MSP Concealed Ducted Unit	OD 3	Yes	530	12,856	10,167	75.0	62.6	17,743	68.0
ID-35	Offices 123,124	FXSQ09TAVJU	0.8	MSP Concealed Ducted Unit	OD 3	Yes	318	8,312	6,189	75.0	62.6	10,919	68.0
ID-23	Offices 135,137,139	FXSQ30TAVJU	2.5	MSP Concealed Ducted Unit	OD 3	Yes	812	25,975	20,336	75.0	62.6	35,145	68.0
ID-24	Offices 129, 131, 133	FXSQ24TAVJU	2.0	MSP Concealed Ducted Unit	OD 3	Yes	742	20,657	15,426	75.0	62.6	27,980	68.0
ID-28	Investig. Storage	FXSQ05TAVJU	0.5	MSP Concealed Ducted Unit	OD 3	Yes	281	5,146	4,403	75.0	62.6	6,790	68.0
ID-29	Chief Deputy Office	FXZQ12TAVJU	1.0	4-Way Discharge Ceiling Cassette (2' x 2')	OD 3	Yes	353	10,261	7,078	75.0	62.6	13,990	68.0
ID-30	Work Room	FXZQ09TAVJU	0.8	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	317	8,037	5,899	75.0	62.6	10,919	68.0
ID-31	Interview Room	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-32	Staff Break Room	FXZQ12TAVJU	1.0	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	353	10,261	7,078	75.0	62.6	13,990	68.0
ID 45	Staff Break Room	FXZQ12TAVJU	1.0	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	353	10,261	7,078	75.0	62.6	13,990	68.0
ID-33	Conference Room	FXZQ09TAVJU	0.8	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	317	8,037	5,899	75.0	62.6	10,919	68.0
ID-40	Kitchenette	FXZQ15TAVJU	1.3	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	405	12,826	9,509	75.0	62.6	17,743	68.0
ID-41	Training/Comm. Storage	FXZQ05TAVJU	0.5	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	300	4,954	4,377	75.0	62.6	6,824	68.0
ID-42	Sheriff Office 121	FXZQ09TAVJU	0.8	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	317	8,037	5,899	75.0	62.6	10,919	68.0
ID-36	Public Meeting	FXZQ09TAVJU	0.8	4-Way Discharge Ceiling Cassette (2' x 2')	OD 4	Yes	317	8,037	5,899	75.0	62.6	10,919	68.0
ID-37	Reception / Waiting	FXSQ36TAVJU	3.0	MSP Concealed Ducted Unit	OD 4	Yes	1,130	31,119	23,087	75.0	62.6	41,287	68.0
ID-38	Pre-Function	FXMQ72MVJU	6.0	Concealed Ducted (Medium Static)	OD 4	Yes	2,048	60,784	48,766	75.0	62.6	84,000	68.0
ID-39	Training / Community Room	FXSQ54TAVJU	4.5	MSP Concealed Ducted Unit	OD 4	Yes	1,377	46,821	34,574	75.0	62.6	62,442	68.0
ID 44	Training / Community Room	FXSQ54TAVJU	4.5	MSP Concealed Ducted Unit	OD 4	Yes	1,377	46,821	34,574	75.0	62.6	62,442	68.0

Appendix 9: VRV Indoor Unit Schedule

ELECTRICAL			DIMENSIONS	WEIGHT	NOTES	Options and Accessories
POWER SUPPLY	Min Circuit Amps	Max Overcurrent Protection	WxHxD	Net		
Voltage - Phase	MCA	MOP	inch	lbs		
208-230V 1ph	0.4	15.0	22.6 x 10.2 x 22.6	36.4		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.8	15.0	21.7 x 9.6 x 31.5	55.0		BRC1E73 (1)
208-230V 1ph	0.8	15.0	21.7 x 9.6 x 31.5	55.0		BRC1E73 (1)
208-230V 1ph	0.8	15.0	21.7 x 9.6 x 31.5	55.0		BRC1E73 (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.8	15.0	21.7 x 9.6 x 31.5	55.0		BRC1E73 (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.4	15.0	22.6 x 10.2 x 22.6	36.4		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	9.0	15.0	54.3 x 18.1 x 43.3	302.0		BRC1E73 (1)
208-230V 1ph	9.0	15.0	54.3 x 18.1 x 43.3	302.0		BRC1E73 (1)
208-230V 1ph	3.3	15.0	61.0 x 9.6 x 31.5	104.0		BRC1E73 (1)
208-230V 1ph	0.8	15.0	21.7 x 9.6 x 31.5	55.0		BRC1E73 (1)
208-230V 1ph	0.8	15.0	21.7 x 9.6 x 31.5	55.0		BRC1E73 (1)
208-230V 1ph	1.6	15.0	39.4 x 9.6 x 31.5	77.0		BRC1E73 (1)
208-230V 1ph	0.4	15.0	22.6 x 10.2 x 22.6	36.4		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	1.4	15.0	27.6 x 9.6 x 31.5	60.0		BRC1E73 (1)
208-230V 1ph	0.8	15.0	21.7 x 9.6 x 31.5	55.0		BRC1E73 (1)
208-230V 1ph	1.8	15.0	39.4 x 9.6 x 31.5	82.0		BRC1E73 (1)
208-230V 1ph	1.8	15.0	39.4 x 9.6 x 31.5	82.0		BRC1E73 (1)
208-230V 1ph	0.8	15.0	21.7 x 9.6 x 31.5	55.0		BRC1E73 (1)
208-230V 1ph	0.4	15.0	22.6 x 10.2 x 22.6	36.4		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.4	15.0	22.6 x 10.2 x 22.6	36.4		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.4	15.0	22.6 x 10.2 x 22.6	36.4		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.4	15.0	22.6 x 10.2 x 22.6	36.4		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	0.3	15.0	22.6 x 10.2 x 22.6	35.3		BRC1E73 (1), BYFQ60C3W1W (1)
208-230V 1ph	2.5	15.0	55.1 x 9.6 x 31.5	101.0		BRC1E73 (1)
208-230V 1ph	9.0	15.0	54.3 x 18.1 x 43.3	302.0		BRC1E73 (1)
208-230V 1ph	3.3	15.0	61.0 x 9.6 x 31.5	104.0		BRC1E73 (1)
208-230V 1ph	3.3	15.0	61.0 x 9.6 x 31.5	104.0		BRC1E73 (1)

VRV Indoor Unit Schedule (continued)

TAG: ROOM	BASIS OF DESIGN (DAIKIN)	NOMINAL TONNAGE	DESCRIPTION	COOLING CAPACITY		HEATING CAPACITY		REFRIGERA
				BTU/h	AMBIENT DESIGN (°F DB)	BTU/h	AMBIENT DESIGN (°F DB / WB)	Factory Charge (lbs)
OD-1	REYQ96XAYDA	8	Air cooled heat recovery (1)	86,574	91.1	86,017	9.6 / 9.0	25.8
OD 2	REYQ216XAYDA	18	Air cooled heat recovery (2)	216,409	91.1	181,916	9.6 / 9.0	51.6
OD 3	REYQ96XAYDA	8	Air cooled heat recovery (1)	78,573	91.1	85,710	9.6 / 9.0	25.8
OD 4	REYQ240XAYDA	20	Air cooled heat recovery (2)	239,489	91.1	187,138	9.6 / 9.0	51.6

ANT CHARGE	CONNECTION RATIO (%)	ELECTRICAL												
		VOLTAGE-PHASE	MIN CIRCUIT AMPS (MCA)				MAX OVERCURRENT PROTECTION (MOP)				RUNNING CURRENT(RLA)			
Add'l Refrigerant (lbs)			mod #1	mod #2	mod #3	total	mod #1	mod #2	mod #3	total	mod #1	mod #2	mod #3	total
n/a	110.6	460V 3ph	21.1			21.1	25.0			25.0	10.5			10.5
n/a	127.8	460V 3ph	21.1	21.1		42.2	25.0	25.0		50.0	12.8	10.5		23.3
n/a	100.3	460V 3ph	21.1			21.1	25.0			25.0	10.5			10.5
n/a	126.9	460V 3ph	21.1	21.1		42.2	25.0	25.0		50.0	12.8	12.8		25.6

DIMENSIONS		EFFICIENCY (NonDucted/Ducted or Specific Combo)							NOTES	Options and Accessories
(WxHxD) (inch)	WEIGHT (lbs)	EER	IEER	COP47	COP17	SCHE	SEER	HSPF		
48.9 x 66.7 x 30.2	727.0	14.6 / 12.5	27.8 / 21.9	4.23 / 3.56	2.63 / 2.31	26.4 / 21.1	n/a / n/a	n/a / n/a		
48.9 x 66.7 x 30.2 / 48.9 x 66.7 x 30.2	727.0 / 727.0	12.4 / 12.3	23.1 / 21.7	3.76 / 3.52	2.34 / 2.2	25.5 / 21.9	n/a / n/a	n/a / n/a		BHFP26P100U (1)
48.9 x 66.7 x 30.2	727.0	14.6 / 12.5	27.8 / 21.9	4.23 / 3.56	2.63 / 2.31	26.4 / 21.1	n/a / n/a	n/a / n/a		
48.9 x 66.7 x 30.2 / 48.9 x 66.7 x 30.2	727.0 / 727.0	11.6 / 11.7	22.2 / 20	3.68 / 3.39	2.34 / 2.16	25.6 / 21.8	n/a / n/a	n/a / n/a		BHFP26P100U (1)

Appendix 10: VRV Outdoor Unit Schedule

VRV ZONES				
VRF NO.	VRF LC ZONES	Total cooling	Sens cooling	Total heating
ID-1	3	7356	5596	2276
ID-2	7	2132	1692	1249
ID-3	9,10	5790	4690	2130
ID-4	11	4594	4154	3041
ID-5	14	4267	3827	1293
ID-6	25	5239	5019	4193
ID-7	24	7234	6794	3752
ID-8	23	1988	1768	559
ID-9	26	6764	5884	2587
ID-10	32,33,34	5038	4598	1564
ID-11	28	5481	4601	3252
ID-12	35	7563	6243	2760
ID-13	18,19	4299	4299	4686
ID-14	22	2070	1850	608
ID-15	21	2137	1917	746
ID-16	20	2964	2744	2697
ID-17	36 (1/2)	42333	39033	18115
ID-18	40	40726	34126	26216
ID-19	39	4411	4191	2353
ID-20	41	4759	4539	2948
ID-21	43	13147	11167	3193
ID-22	53	6850	6410	3036
ID-23	54,55,56	17155	16495	7666
ID-24	57,58,59	14964	14304	6498
ID-25	52	1831	1391	506
ID-26	61	2394	1954	506
ID-27	62	2070	1850	608
ID-28	60,63	3726	3726	2239
ID-29	66	6340	5900	5210
ID-30	51	5731	5511	665
ID-31	49	1730	1290	445
ID-32	80 (1/2)	9015	6815	751
ID-33	79	6902	5142	1091
ID-34	67,68,69	9880	9220	9033
ID-35	70,71	6356	5916	5728
ID-36	38	5940	5280	3650
ID-37	44	23857	17257	4174
ID-38	46	34793	33913	17077
ID-39	76 (1/2)	36302	31682	18940
ID-40	77	8241	7581	677
ID-41	74	2516	2296	1734
ID-42	73	6023	5583	4526
ID-43	36 (1/2)	42333	39033	18115
ID-44	76 (1/2)	36302	31682	18940
ID-45	80 (1/2)	9015	6815	751

Appendix 11: VRV Zoning Heating and Cooling Loads

Air Spreadsheet - Per ANSI/ASHRAE Standard 62.1-2010 and 170, including VAMC Guidelines

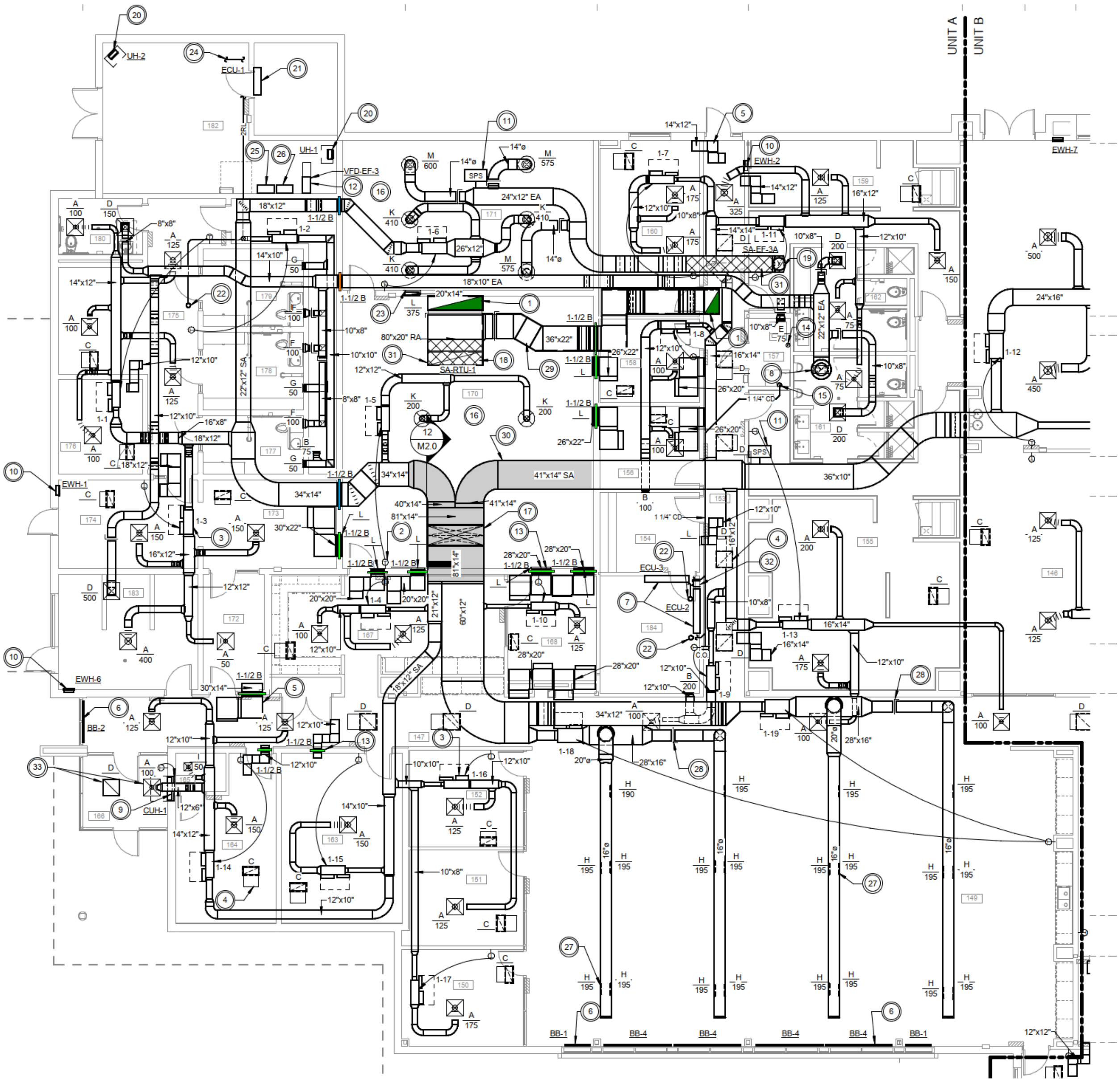
Prepared by SCHEESER BUCKLEY MAYFIELD, LLC
SBM Job No:
Date:
Completed By:

MAKE ENTRIES IN THESE CELLS
DO **NOT** MAKE ENTRIES IN THESE CELLS
DO **NOT** MAKE ENTRIES IN THESE CELLS

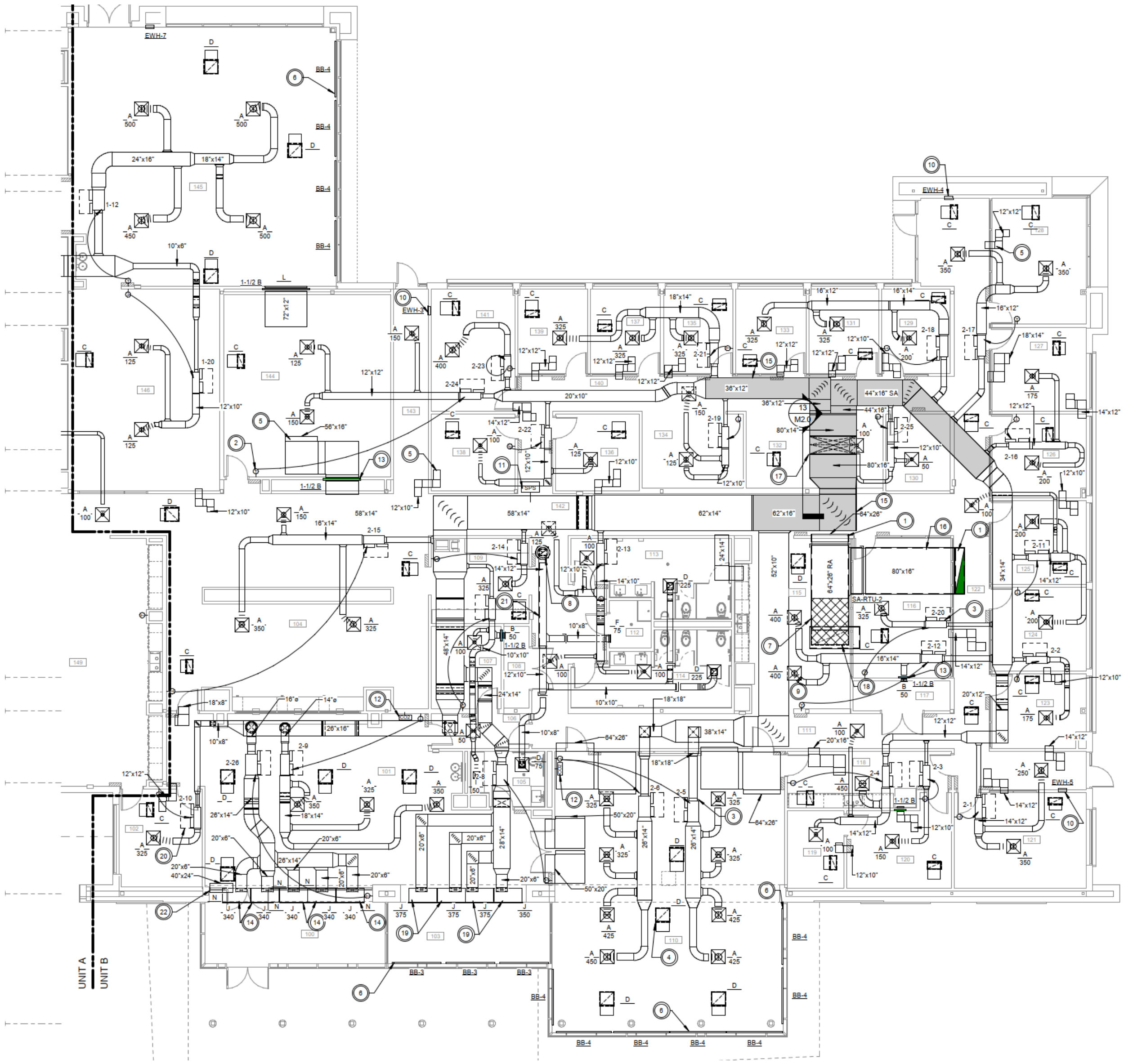
Zone No.	Room No.	Room Description	Az Floor area of zone square feet	Pz Zone population, largest # of people expected	Table 6.1 Space type (select from pull-down list)	P/1000SQFT Occupant Density	Pz Calculated Occupants	Rp People OA air rate from Table 6.1 cfm/person	Ra Area OA air rate from Table 6.1 cfm/sf	Pz*Rp People OA cfm	Az*Ra Area OA cfm	Ez Zone air distribution effectiveness, Table 6.2 or ASHRAE Standard 129	Voz OA flow to the zone corrected for zone air distribution effectiveness, (Pz*Rp + Az*Ra)/Ez, cfm	Vpz Primary airflow to the zone from air handler. In VAV systems, use the design value. cfm
1	182	182 Mech/elec	435	0	N/A	0	0.0	0	0.00	0	0	0.8	0	350
2	180	180 Staff Toilet	68	0	N/A	0	0.0	0	0.00	0	0	0.8	0	100
3	175	175 Officer Work Stations	356	8	Office Space	5	0.0	5	0.06	40	21	0.8	77	350
4	179	179 Male Holding	91	1	Cell (correctional)	25	0.0	5	0.12	5	11	0.8	20	50
5	178	178 Female Holding	91	1	Cell (correctional)	25	0.0	5	0.12	5	11	0.8	20	50
6	Cha	Chase	162	0	N/A	0	0.0	0	0.00	0	0	0.8	0	75
7	176	176 Interview Room	114	2	Conference/Meeting	50	0.0	5	0.06	10	7	0.8	21	100
8	177	177 Juvenile Holding	80	1	Cell (correctional)	25	0.0	5	0.12	5	10	0.8	18	50
9	174	174 Intake	180	2	Booking/Waiting (correctional)	50	0.0	8	0.06	15	11	0.8	32	150
10	173	173 Processing Room	175	3	Booking/Waiting (correctional)	50	0.0	8	0.06	23	11	0.8	41	150
11	183	183 K-9 Officer Washroom/kennel	221	2	N/A	0	0.0	0	0.00	0	0	0.8	0	**400**
12	172	172 Salley Port	103	0	Corridors	0	0.0	0	0.06	0	6	0.8	8	50
13	169	169 Elec	17	0	N/A	0	0.0	0	0.00	0	0	0.8	0	25
14	167	167 Officer Evidence Processing	340	2	Office Space	5	0.0	5	0.06	10	20	0.8	38	225
15	147	147 Corridor	745	0	Corridors	0	0.0	0	0.06	0	45	0.8	56	550
16	166	166 Staff Entrance	91	0	Corridors	0	0.0	0	0.06	0	5	0.8	7	**100**
17	165	165 Fitting	31	0	Occupiable Storage Rooms for Dry Ma	2	0.1	5	0.06	0	2	0.8	3	**50**
18	164	164 Uniform Storage	216	0	Occupiable Storage Rooms for Dry Ma	2	0.4	5	0.06	2	13	0.8	19	150
19	163	163 Armory	298	0	Occupiable Storage Rooms for Dry Ma	2	0.6	5	0.06	3	18	0.8	26	150
20	150	150 Road Patrol Lieut Office	168	1	Office Space	5	0.0	5	0.06	5	10	0.8	19	175
21	151	151 Road Patrol Lieut Office	159	1	Office Space	5	0.0	5	0.06	5	10	0.8	18	125
22	152	152 Road Patrol Lieut Office	160	1	Office Space	5	0.0	5	0.06	5	10	0.8	18	125
23	168	168 Evidence Lieut Office	147	1	Office Space	5	0.0	5	0.06	5	9	0.8	17	125
24	170	170 Evidence Storage Room	987	2	Occupiable Storage Rooms for Dry Ma	2	0.0	5	0.06	10	59	0.8	87	400
25	171	171 Drugs, Guns, Money Evidence St	543	1	Occupiable Storage Rooms for Dry Ma	2	0.0	5	0.06	5	33	0.8	47	**1,225**
26	160	160 Bunk Room	254	4	Bedroom/Living Room (hotel/dormitory	10	0.0	5	0.06	20	15	0.8	44	350
27	153	153 Corridor	334	0	Corridors	0	0.0	0	0.06	0	20	0.8	25	325
28	159	159 Womens Locker Room	370	4	N/A	0	0.0	0	0.00	0	0	0.8	0	275
29	162	162 Womens Toilet	155	0	N/A	0	0.0	0	0.00	0	0	0.8	0	75
30	157	157 Janitor	40	0	Occupiable Storage Rooms for Liquids	2	0.1	5	0.12	0	5	0.8	7	25
31	161	161 Mens Toilet	148	0	N/A	0	0.0	0	0.00	0	0	0.8	0	75
32	158	158 Computer Tech Office	120	1	Office Space	5	0.0	5	0.06	5	7	0.8	15	100
33	156	156 Computer Tech Office	121	1	Office Space	5	0.0	5	0.06	5	7	0.8	15	100
34	154	154 Server/i Troom	170	0	N/A	0	0.0	0	0.00	0	0	0.8	0	**200**
35	155	155 Mens Locker Room	726	6	N/A	0	0.0	0	0.00	0	0	0.8	0	375
36	149	149 Patrol Room	2345	30	Office Space	5	0.0	5	0.06	150	141	0.8	363	4,575
37	143	143 Corridor	150	0	Corridors	0	0.0	0	0.06	0	9	0.8	11	150
38	102	102 Public Meeting	171	3	Conference/Meeting	50	0.0	5	0.06	15	10	0.8	32	325
39	146	146 Phys Tactics Training And Gear	619	1	Health Club/Weight Room	10	0.0	20	0.06	20	37	0.8	71	250
40	145	145 Fitness Training	1451	30	Health Club/Weight Room	10	0.0	20	0.06	600	87	0.8	859	**1,950**
41	144	144 Records Room	626	1	Occupiable Storage Rooms for Dry Ma	2	0.0	5	0.06	5	38	0.8	53	275
42	142	142 Corridor	725	0	Corridors	0	0.0	0	0.06	0	44	0.8	54	275

Zone No.	Room No.	Room Description	Az Floor area of zone square feet	Pz Zone population, largest # of people expected	Table 6.1 Space type (select from pull-down list)	P/1000SQFT Occupant Density	Pz Calculated Occupants	Rp People OA air rate from Table 6.1 cfm/person	Ra Area OA air rate from Table 6.1 cfm/sf	Pz*Rp People OA cfm	Az*Ra Area OA cfm	Ez Zone air distribution effectiveness, Table 6.2 or ASHRAE Standard 129	Voz OA flow to the zone corrected for zone air distribution effectiveness, (Pz*Rp + Az*Ra)/Ez, cfm	Vpz Primary airflow to the zone from air handler. In VAV systems, use the design value. cfm
43	104	104 Clerk Counter	840	9	Office Space	5	0.0	5	0.06	45	50	0.8	119	675
44	101	101 Reception/waiting	1098	30	Reception Areas	30	0.0	5	0.06	150	66	0.8	270	1,025
45	100	100 Secure Vestibule	283	0	Corridors	0	0.0	0	0.06	0	17	0.8	21	1,700
46	103	103 Prefunction	254	4	Office Space	5	0.0	5	0.06	20	15	0.8	44	2,000
47	105	105 Public Toilet	78	0	N/A	0	0.0	0	0.00	0	0	0.8	0	50
48	106	106 Vestibule	71	0	Corridors	0	0.0	0	0.06	0	4	0.8	5	50
49	107	107 Interview Room	117	2	Conference/Meeting	50	0.0	5	0.06	10	7	0.8	21	100
50	108	108 Elec	42	0	N/A	0	0.0	0	0.00	0	0	0.8	0	**50**
51	109	109 Work Room	175	1	Office Space	5	0.0	5	0.06	5	11	0.8	19	325
52	138	138 Interview Room	133	2	Conference/Meeting	50	0.0	5	0.06	10	8	0.8	22	100
53	141	141 Chief Detective Office	210	2	Office Space	5	0.0	5	0.06	10	13	0.8	28	400
54	139	139 Sargent Office	121	1	Office Space	5	0.0	5	0.06	5	7	0.8	15	325
55	137	137 Sargent Office	121	1	Office Space	5	0.0	5	0.06	5	7	0.8	15	325
56	135	135 Detective Office	121	1	Office Space	5	0.0	5	0.06	5	7	0.8	15	325
57	133	133 Detective Office	121	1	Office Space	5	0.0	5	0.06	5	7	0.8	15	325
58	131	131 Detective Office	121	1	Office Space	5	0.0	5	0.06	5	7	0.8	15	325
59	129	129 Detective Office	119	1	Office Space	5	0.0	5	0.06	5	7	0.8	15	200
60	140	140 Corridor	372	0	Corridors	0	0.0	0	0.06	0	22	0.8	28	150
61	136	136 Interview Room	133	2	Conference/Meeting	50	0.0	5	0.06	10	8	0.8	22	125
62	134	134 Admin Asisstant	160	1	Office Space	5	0.0	5	0.06	5	10	0.8	18	125
63	132	132 Investig. File Storage	217	0	Occupiable Storage Rooms for Dry Ma	2	0.4	5	0.06	2	13	0.8	19	100
64	130	130 Investig Supply Storage	101	0	Occupiable Storage Rooms for Dry Ma	2	0.2	5	0.06	1	6	0.8	9	50
65	111	111 Corridor	498	0	Corridors	0	0.0	0	0.06	0	30	0.8	37	200
66	128	128 Chief Deputy Office	245	2	Office Space	5	0.0	5	0.06	10	15	0.8	31	350
67	126	126 Captain Office	163	1	Office Space	5	0.0	5	0.06	5	10	0.8	18	200
68	127	127 Captain Office	163	1	Office Space	5	0.0	5	0.06	5	10	0.8	18	175
69	125	125 Captain Office	163	1	Office Space	5	0.0	5	0.06	5	10	0.8	18	200
70	124	124 Captain Office	163	1	Office Space	5	0.0	5	0.06	5	10	0.8	18	200
71	123	123 Training Lieutenant Office	145	1	Office Space	5	0.0	5	0.06	5	9	0.8	17	175
72	122	122 Corridor	565	0	Corridors	0	0.0	0	0.06	0	34	0.8	42	700
73	121	121 Sheriff Office	260	2	Office Space	5	0.0	5	0.06	10	16	0.8	32	350
74	120	120 Training/comm. Storage	176	1	Occupiable Storage Rooms for Dry Ma	2	0.0	5	0.06	5	11	0.8	19	150
75	119	119 A/v Closet	89	0	N/A	0	0.0	0	0.00	0	0	0.8	0	100
76	110	110 Training/community Room	1323	42	Classrooms (age 9 plus)	35	0.0	10	0.12	420	159	0.8	723	3,725
77	118	118 Kitchenette	178	3	Break Rooms (office)	50	0.0	5	0.12	15	21	0.8	45	450
78	117	117 Storage	60	0	Occupiable Storage Rooms for Dry Ma	2	0.1	5	0.06	1	4	0.8	5	**50**
79	116	116 Conference Room	287	8	Conference/Meeting	50	0.0	5	0.06	40	17	0.8	72	325
80	115	115 Staff Break Room	395	20	Break Rooms (office)	50	0.0	5	0.12	100	47	0.8	184	800
81	114	114 Women	213	0	N/A	0	0.0	0	0.00	0	0	0.8	0	100
82	113	113 Men	213	0	N/A	0	0.0	0	0.00	0	0	0.8	0	100
83	112	112 Jan	42	0	Occupiable Storage Rooms for Liquids	2	0.1	5	0.12	0	5	0.8	7	25
84	154	154 It Workroom	115	1	Occupiable Storage Rooms for Liquids	2	0.0	5	0.12	5	14	0.8	24	100
			24,967	**253**			**2.0**			**1903**	**1452.9**		**4,194**	**32,325**

Appendix 12: SBM Airflow Ventilation Excel sheet



Appendix 13: Original SBM Design Floor Plan Unit A



Appendix 14: Original SBM Design Floor Plan Unit B

Source: *2021 ASHRAE Handbook – Fundamentals – IP Edition – Supported by ASHRAE Research*

Closest Location in book: **Yeager, West Virginia**

Latitude: 38.38 N

Longitude: 81.59 W

Elevation: 910 ft

Heating Dry Bulb (deg F)

- 99.6% : 9.6
- 99% : 14.8

Cooling Dry Bulb/Mean Coincident Wet Bulb Temperature (deg F)

- 0.4% : 91.1 / 72.9
- 1% : 88.8 / 72.4
- 2% : 86.7 / 71.7

Evaporation Wet Bulb/Mean Coincident Dry Bulb Temperature (deg F)

- 0.4% : 76.6 / 85.7
- 1% : 75.3 / 83.9

Dehumidification Dew Point Temp (deg F) / Humidity Ratio (grains moisture/lb. dry air) / Mean Coincident Dry Bulb Temp (deg F)

- 0.4% : 74.0 / 131.1 / 80.3
- 1% : 72.7 / 125.4 / 78.8

Extreme Annual Wind Speed (mph)

- 1% : 17.9
- 2.5% : 15.3
- 5% : 12.5

Annual Heating and Cooling Degree-Days, base 65 deg F : 4385 / 1108

Appendix 15: ASHRAE Location Data for Yeager, WV

Utility Monthly Charge	$35
Utility Taxes	5.7%
Rate Type	Flat
Flat Consumption Rate	0.05 $/kWh
Flat Demand Rate	18 $/kW
Demand Ratchet	60%

Appendix 16: Electricity Costs

Utility Monthly Charge	$32
Rate Type	Unbundled Flat
Generation	3.4376 $/MCF
Transmission	3.22 $/MCF
Total	6.6576 $/MCF

Appendix 17: Natural Gas Costs

Utility Monthly Charge	$211.45
Utility Taxes	2%
Rate Type	Stepped
Consumption < 1000 Gallons	$23.43 $/1000 Gal.
All Remaining (>1000 Gallons)	$14.54 $/1000 Gal.

Appendix 18: Water Costs

Outside	4-inch Brick
↓	Wall Air Space Resistance
	R5 1 inch Insulation Board
	½ inch Fiberboard Sheathing
	R15 3 inch Insulation Board
Inside	5/8 inch Gypsum Board

Appendix 19: Exterior Wall Construction Layers

Outside Surface Convective Heat Transfer Coefficient	3.62 Btu/(hr·ft²·F)
Inside Surface Convective Heat Transfer Coefficient	1.39 Btu/(hr·ft²·F)
Solar Heat Gain Coefficient (SHGC)	0.395
Direct Solar Transmission	0.315
Visible Transmittance	0.509
U-Factor (ASHRAE Calc)	0.541 Btu/(hr·ft²·F)

Appendix 20: Exterior Window Data

[see sheets M1.0 – M5.3 below for design set]

Appendix 21: Full design set of VRV system (BELOW)

HVAC GENERAL NOTES

1. THE GENERAL NOTES LISTED HERE APPLY TO ALL HVAC DRAWINGS IN ADDITION TO ANY ADDITIONAL DRAWING NOTES ON THE INDIVIDUAL DRAWINGS.

2. REFER ALSO TO DUCTWORK MATERIAL SCHEDULE AND NOTES FOR ADDITIONAL GENERAL NOTES APPLICABLE TO DUCTWORK.

3. SEE CODED NOTES ON INDIVIDUAL DRAWING SHEETS FOR SPECIFIC INSTRUCTIONAL NOTES.

4. COORDINATE WITH GENERAL TRADES WORK, PLUMBING WORK, FIRE PROTECTION WORK, ELECTRICAL WORK AND OTHER WORK.

5. THE MECHANICAL DESIGN DRAWINGS ARE DIAGRAMMATIC AND ARE NOT INTENDED TO SHOW EXACT LOCATION OF EQUIPMENT, PIPING AND DUCTWORK UNLESS DIMENSIONS ARE GIVEN OR OTHERWISE IMPLIED FOR CLEARANCES, ETC. PIPING, DUCTWORK AND MECHANICAL EQUIPMENT ARE TO BE INSTALLED ALONG THE GENERAL PLANS SHOWN ON THE DRAWINGS, BUT KEEPING IN MIND ACTUAL BUILDING CONDITIONS WHICH MUST BE CONFORMED WITH IN THE ACTUAL WORK. CONTRACTORS IN THEIR BIDS ARE REQUIRED TO INCLUDE ALL LABOR AND MATERIALS AND OTHER RELATED WORK NECESSARY TO PROVIDE MINOR OFFSETS IN MECHANICAL WORK AS REQUIRED TO AVOID CONFLICT WITH OTHER WORK ON THIS PROJECT, OR AS REQUIRED IN ORDER TO OBTAIN MAXIMUM HEAD ROOM OR EQUIPMENT ACCESS IN SPACES.

6. MAINTAIN REQUIRED RIGGING ACCESS CLEARANCES. COORDINATE CLEARANCE REQUIREMENTS WITH OTHER TRADES.

7. SEE ARCHITECTURAL DRAWINGS FOR LOCATIONS OF FIRE AND SMOKE WALLS AND RATED STRUCTURES. SEE DETAILS AND SPECIFICATIONS FOR PIPE PENETRATION SEAL REQUIREMENTS.

8. H.C. IS TO COORDINATE ALL MASONRY PENETRATION LOCATIONS AND SIZES WITH G.C.

9. COORDINATE EXACT POSITIONING OF FLOOR DRAINS WITH PLUMBING CONTRACTOR TO SERVE HVAC EQUIPMENT AS INTENDED, AND TO AVOID TRIPPING HAZARDS WITH ABOVE FLOOR DRAIN PIPING.

10. DO NOT ROUTE DUCTWORK OR PIPING OVER ELECTRICAL EQUIPMENT.

11. BALANCE AIR QUANTITY FOR RETURN INLETS TO EQUAL THE SUM OF SUPPLY AIR INTRODUCED TO THE SPACE, UNLESS NOTED OTHERWISE.

12. UNLESS OTHERWISE INDICATED, ALL PIPING TO RUN GENERALLY BELOW DUCTWORK FOR ACCESS TO VALVING. DO NOT OBSTRUCT EQUIPMENT OR ACCESS DOORS. AVOID DUCTWORK OVER LIGHTS WHEREVER POSSIBLE.

13. EQUIPMENT CONNECTION ARRANGEMENTS, FLANGES, UNIONS, VALVING, ETC. ARE NOT TYPICALLY SHOWN ON PLAN VIEWS. REFER TO DETAILS AND FLOW DIAGRAMS FOR REQUIREMENTS. INSTALL ALL VALVES AND OTHER ITEMS REQUIRING OR FACILITATING MAINTENANCE IN ACCESSIBLE LOCATIONS, AND SO AS TO NOT OBSTRUCT MAINTENANCE ON EQUIPMENT SERVED.

14. SEE TEMPERATURE CONTROL DRAWINGS AND COORDINATE WITH TEMPERATURE CONTROL CONTRACTORS FOR INSTRUMENTATION DEVICES REQUIRED TO BE INSTALLED IN PIPING AND DUCTWORK, TOGETHER WITH NECESSARY CLEARANCES FOR SAME.

15. PROVIDE CLEAR LAMINATE TAGS WITH BLACK LETTERS ON CEILING TILES INDICATING LOCATIONS OF ALL VALVES, AIR TERMINAL UNITS, AND DIFFERENTIAL PRESSURE TRANSMITTERS. LABEL NAMING CONVENTION TO MATCH CONTROL ADDRESS IN BUILDING AUTOMATION SYSTEM. COORDINATE HEIGHT OF TEXT WITH OWNER PRIOR TO INSTALLATION. TAGS MUST BE SUBMITTED AND APPROVED BY ARCHITECT AND ENGINEER BEFORE INSTALLATION.

16. WHERE ACCESS PANELS ARE REQUIRED, THE HVAC CONTRACTOR SHALL FURNISH THE ACCESS PANELS WITH INSTALLATION COSTS ASSUMED BY THE HVAC CONTRACTOR, BUT INSTALLED BY THE GENERAL CONTRACTOR. ANY ACCESS PANELS PURCHASED DURING CONSTRUCTION BY THE HVAC CONTRACTOR SHALL MATCH THOSE ALREADY PURCHASED BY THE GENERAL CONTRACTOR.

17. DUCT MOUNTED ACCESS DOORS TO BE PROVIDED WITH VIEW WINDOWS. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.

18. H.C. SHALL COORDINATE WITH G.C. FOR FIRE PROTECTION SEAL MATERIAL AND ACCESS PANEL TYPE AND MANUFACTURER.

19. ALL AIR TERMINAL UNITS, HEATING TERMINALS AND REHEAT COILS SHALL BE PROVIDED WITH WALL-MOUNTED THERMOSTATS UNLESS NOTED ON THE PLANS TO BE EQUIPPED WITH INTEGRAL THERMOSTATS. REFER TO PLANS FOR APPROXIMATE THERMOSTAT LOCATIONS. COORDINATE WITH OTHER TRADES. IF A THERMOSTAT IS NOT SHOWN ON THE PLANS, COORDINATE WITH ENGINEER. CONTRACTOR SHALL SUBMIT A FLOOR PLAN WITH APPROXIMATE LOCATIONS OF ALL THERMOSTATS.

20. REFER TO ARCHITECTURAL PLANS FOR EXACT LOCATIONS OF GRILLES AND DIFFUSERS.

21. ALL TRANSFER AIR DUCTWORK TO BE INSTALLED ABOVE CEILING WHERE APPLICABLE.

EQUIPMENT KAIC RATING REQUIREMENT

UNLESS NOTED OTHERWISE, PROVIDE ALL MAJOR EQUIPMENT WITH MINIMUM SCCR RATING OF 65 KAIC.

HVAC SYMBOL LEGEND

ABBREVIATION	SYMBOL	DESCRIPTION
2RL	2RL	REFRIGERANT LINES - CONFIRM PIPING QTY AND SIZES WITH EQ. MANUFACTURERS
CD	CD	A/C CONDENSATE DRAIN
	H	HUMIDITY SENSOR
	S	WALL SWITCH (SEE TEMPERATURE CONTROLS)
	T	TEMPERATURE SENSOR
		THERMOSTAT
	H	HUMIDISTAT
		LOUVERS (SEE SCHEDULE)
	-	CODED NOTE (SEE SCHEDULE)
E.C.	E.C.	ELECTRICAL CONTRACTOR
F.P.C.	F.P.C.	FIRE PROTECTION CONTRACTOR
G.C.	G.C.	GENERAL CONTRACTOR
H.C.	H.C.	HVAC CONTRACTOR
P.C.	P.C.	PLUMBING CONTRACTOR
T.C.C.	T.C.C.	TEMPERATURE CONTROL SUB-CONTRACTOR
A.D.	A.D.	ACCESS DOOR
A.F.F.	A.F.F.	ABOVE FINISHED FLOOR
A.L.	A.L.	ACTIVE LENGTH
MFR.	MFR.	MANUFACTURER
N.O.	N.O.	NORMALLY OPEN
N.C.	N.C.	NORMALLY CLOSED
TYP.	TYP.	TYPICAL
E.A.	E.A.	EXHAUST AIR
R.A.	R.A.	RETURN AIR
S.A.	S.A.	SUPPLY AIR
M.O.B.D.	M.O.B.D.	MANUAL OPPOSED BLADE DAMPER
O.B.D.	O.B.D.	OPPOSED BLADE DAMPER
		FLOW DIRECTION INDICATOR (VAPOR)
		FLOW DIRECTION INDICATOR (LIQUID)
	XXX CFM	FLOW DIRECTION INDICATOR (VAPOR) W/ CFM QUANTITY GIVEN
1 1/2 B	1 1/2 B	1-1/2 HOUR TYPE B FIRE DAMPER
	A.D. A.D.	ACCESS DOOR IN BOTTOM OF DUCT OR SIDE OF DUCT
		BLANK OFF PORTION OF DIFFUSER
		90° ELBOW WITH TURNING VANES
		SQUARE-TO-ROUND DUCT TRANSITION
		MANUAL BALANCING DAMPER
		AUTOMATIC CONTROL DAMPER

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PROJECT

RALEIGH COUNTY
SHERIFF'S DEPARTMENT

OWNER

RALEIGH COUNTY
COMMISSION

LOCATION

BECKLEY, WV

REVISIONS

DATE

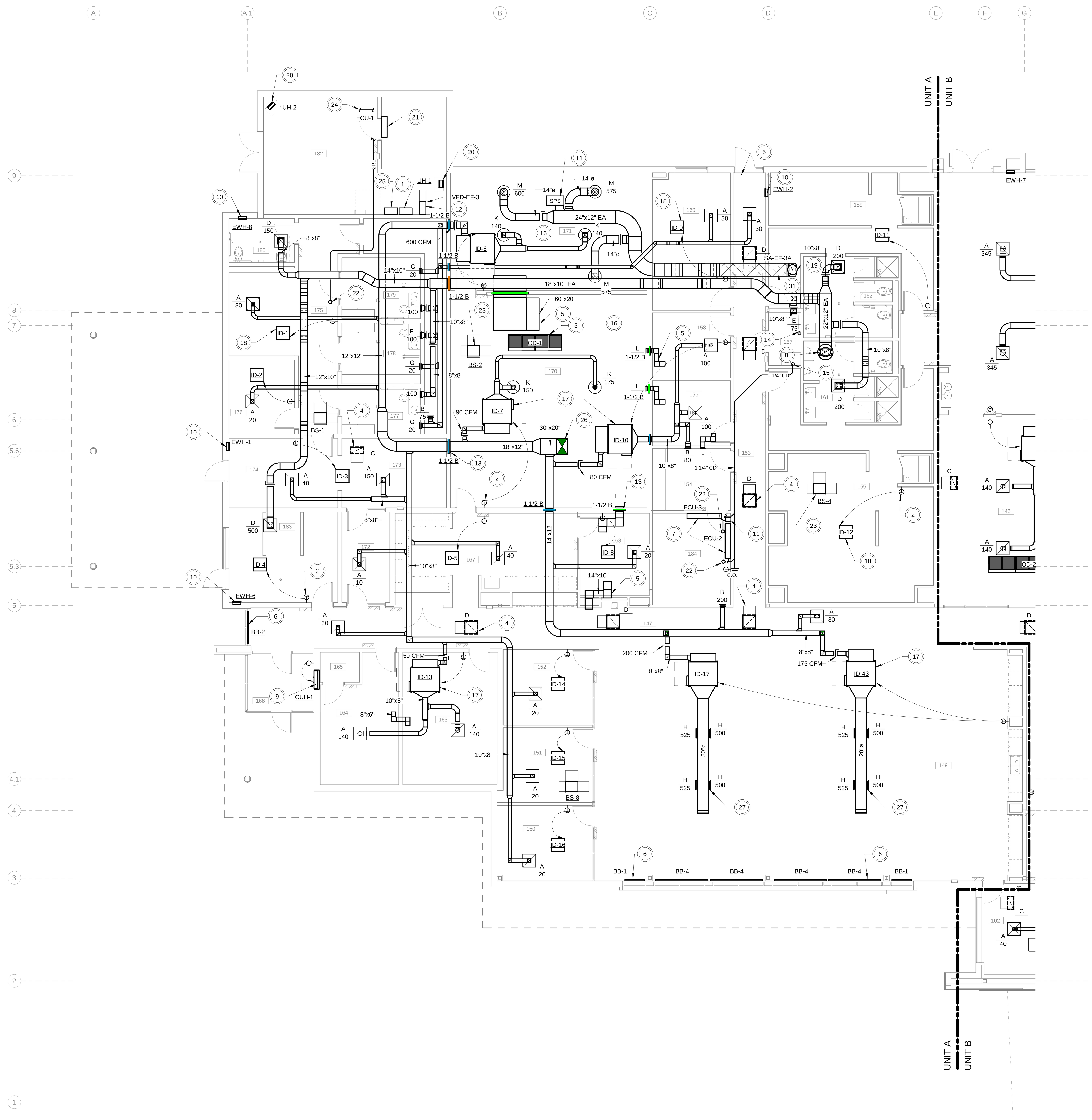
3/01/2022

TITLE

HVAC GENERAL NOTES
AND SYMBOL LEGEND

DRAWING NUMBER

M1.0



GROUND FLOOR PLAN - UNIT A - HVAC

1/8" = 1'-0"

PLAN NOTES

A. SEE SHEET M1.0 FOR HVAC GENERAL NOTES AND SYMBOL LEGEND.

B. SEE SHEET SERIES M1.X FOR HVAC NEW WORK FLOOR PLANS.

C. SEE SHEET SERIES M2.X FOR HVAC DETAILS.

D. SEE SHEET M3.0 FOR HVAC TEMPERATURE CONTROLS.

E. SEE SHEET SERIES M4.X FOR HVAC SCHEDULES.

F. SEE SHEET SERIES M5.X FOR VRV FLOW DIAGRAMS PIPING AND WIRING

G. SEE DIFFUSER CONNECTION DETAIL FOR SIZE OF DUCT RUNOUTS TO DIFFUSERS, REGISTERS AND GRILLES AND DAMPERING REQUIREMENTS. DAMPERING REQUIREMENTS SHALL APPLY TO ALL SUPPLY AIR DUCT RUNOUTS TO ALL DIFFUSERS AND GRILLES WHETHER SHOWN ON FLOOR PLANS OR NOT. INSTALL DAMPERS AS CLOSE TO MAINS AS POSSIBLE IN ACCESSIBLE LOCATIONS.

H. H.C. TO INSTALL ADDITIONAL OFFSETS IN DUCTWORK AS REQUIRED TO INSTALL DUCTWORK TIGHT TO BOTTOM OF STEEL.

I. REFER TO ARCHITECTURAL REFLECTED CEILING PLANS FOR FINAL DIFFUSER AND GRILLE LAYOUTS.

J. MINIMIZE REFRIGERANT PIPING TRANSITIONS TO AVOID EXCEEDING MANUFACTURER'S MAXIMUM ALLOWABLE PIPING LENGTHS. TRANSITION DUCTWORK AND OTHER MECHANICAL COMPONENTS AROUND REFRIGERANT PIPING.

CODED NOTES

1. TEMPERATURE CONTROL FRONT END WITH DATA DROP.

2. WALL MOUNTED THERMOSTAT. TYPICAL.

3. VRV CONDENSING UNIT ON LOW ROOF ABOVE. MOUNT ON 18" EQUIPMENT RAILS AND VIBRATION ISOLATORS. SEE EQUIPMENT RAIL DETAIL. SEE PIPE CURB DETAIL FOR REQUIREMENTS FOR PIPING PENETRATING ROOF TO SERVE CONDENSING UNIT. SEE SCHEDULE FOR SIZE/MODEL REQUIREMENTS BASED ON ALTERNATE ACCEPTANCE. COORDINATE ROUTING REQUIREMENTS WITH FLOW DIAGRAMS AND MANUFACTURER.

4. RETURN AIR BOOT. SEE DETAIL. TYPICAL.

5. TRANSFER AIR DUCTWORK. TYPICAL.

6. ELECTRIC BASEBOARD HEAT. TYPICAL.

7. SERVER ROOM INDOOR "LIEBERT DATA MATE" UNIT OR APPROVED EQUAL MOUNTED HIGH ON WALL. EXTEND 1" A/C CONDENSATE FROM UNIT AS SHOWN. EXTEND REFRIGERANT PIPING FROM UNIT AND TO ASSOCIATED OUTDOOR UNIT. VERIFY REFRIGERANT PIPING SIZES AND MAX LENGTH REQUIREMENTS WITH MANUFACTURER.

8. EA DUCT UP TO EF-1 ON ROOF ABOVE. TRANSITION TO FAN INLET AS REQUIRED.

9. FULLY RECESSED WALL MOUNTED ELECTRIC CABINET UNIT HEATER. SEE DETAIL FOR INSTALLATION INSTRUCTIONS.

10. ELECTRIC WALL HEATER. SEE DETAIL FOR INSTALLATION INSTRUCTIONS. TYPICAL.

11. APPROXIMATE LOCATION FOR SERVER ROOM LIEBERT UNIT TEMPERATURE AND HUMIDITY SENSORS.

12. VARIABLE FREQUENCY DRIVE MOUNTED ON WALL.

13. 1-1/2 HOUR RATED TYPE B FIRE DAMPER. TYPICAL.

14. EXTEND 6" DIAMETER ALUMINUM DRYER EXHAUST VENT FROM DRYER. ALUMINUM DUCTWORK SHALL HAVE NO PENETRATING FASTENERS. EXTEND THROUGH ROOF PER PIPE CURB DETAIL.

15. TERMINATE 1-1/4" CD PIPING OVER MOP BASIN WITH AIR GAP. INSTALL TIGHT DOWN ALONG WALL.

16. MAINTAIN 9' CLEAR A.F.F. FOR DUCTWORK, VRV UNITS, DIFFUSERS AND GRILLES THIS ROOM.

17. DUCTED VRV INDOOR UNIT. BALANCE TO OUTSIDE AIR CFM INDICATED. SEE FLOW DIAGRAMS FOR REFRIGERANT PIPING REQUIREMENTS. TYPICAL.

18. CEILING CASSETTE VRV INDOOR UNIT. BALANCE TO OUTSIDE AIR CFM INDICATED. SEE FLOW DIAGRAMS FOR REFRIGERANT PIPING REQUIREMENTS. TYPICAL.

19. 24"x12" EA DUCT UP TO THROUGH ROOF WITH CURB SERVING EF-3. SEE DETAIL FOR PENETRATION REQUIREMENTS. TRANSITION TO 18" DIAMETER PRIOR TO ROOF PENETRATION.

20. ELECTRIC UNIT HEATER MOUNTED HIGH ABOVE FLOOR. COORDINATE FINAL LOCATION WITH PLUMBING AND ELECTRICAL EQUIPMENT IN SPACE. SEE DETAIL FOR INSTALLATION REQUIREMENTS.

21. INDOOR SPLIT SYSTEM ENVIRONMENTAL CONDITIONING UNIT MOUNTED ON WALL. EXTEND RL, RS AND 3/4" CD PIPING TO ECU. VERIFY REFRIGERANT PIPING SIZES AND MAX LENGTH REQUIREMENTS WITH UNIT MANUFACTURER PRIOR TO ORDERING.

22. RL/RS PIPING UP TO OUTDOOR CONDENSING UNIT. SEE PIPE CURB DETAIL FOR ROOF PENETRATION REQUIREMENTS.

23. INSTALL VRV BRANCH SELECTOR BOX ABOVE CEILING. COORDINATE ROUTING REQUIREMENTS WITH VRV FLOW DIAGRAMS. TYPICAL.

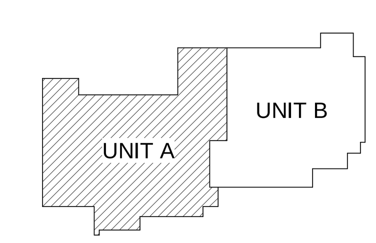
24. EXTEND 1" CD PIPING TO NEARBY FLOOR SINK. ROUTE ALONG WALLS TO AVOID TRIPPING HAZARD.

25. TEMPERATURE CONTROL PANEL AS REQUIRED.

26. 30" X 20" S.A. DUCTWORK UP THROUGH ROOF TO MAU-1.

ROOM LEGEND

147	CORR.
149	PATROL ROOM
150	ROAD PATROL LIEUT. OFFICE
151	ROAD PATROL LIEUT. OFFICE
152	ROAD PATROL LIEUT. OFFICE
153	CORR.
154	IT WORK ROOM
155	MEN'S LOCKER ROOM
156	COMPUTER TECH OFFICE
157	JAN.
158	COMPUTER TECH OFFICE
159	WOMEN'S LOCKER ROOM
160	BUNK ROOM
161	MEN'S TLT.
162	WOMEN'S TLT.
163	ARMORY
164	UNIFORM STORAGE
165	FITTING
166	STAFF ENTRANCE
167	OFFICER EVIDENCE PROCESSING
168	EVIDENCE LIEUT. OFFICE
170	EVIDENCE STORAGE ROOM
171	DRUGS, GUNS, MONEY EVIDENCE STORAGE ROOM
172	SALLYPORT
173	PROCESSING ROOM
174	INTAKE
175	OFFICER WORK STATIONS
176	INTERVIEW ROOM
177	JUVENILE HOLDING
178	FEMALE HOLDING
179	MALE HOLDING
180	STAFF TLT.
181	MECH
182	MECHANICAL/ ELECTRICAL
183	K-9 OFFICER WASHROOM/ KENNEL
184	SERVER



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PROJECT

RALEIGH COUNTY SHERIFF'S DEPARTMENT

OWNER

RALEIGH COUNTY COMMISSION

LOCATION

BECKLEY, WV

REVISIONS

DATE

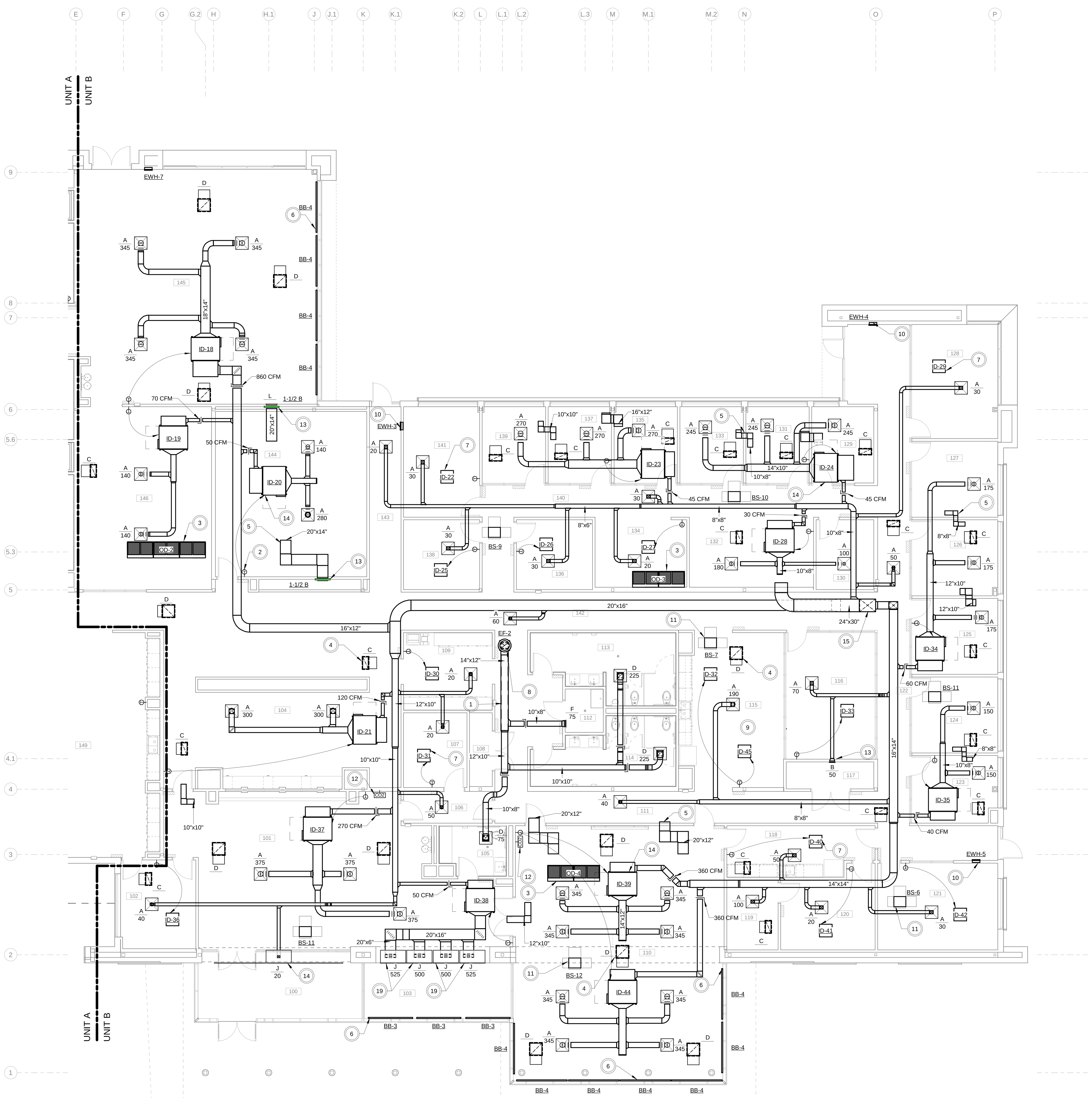
3/01/2022

TITLE

GROUND FLOOR PLAN - UNIT A - HVAC

DRAWING NUMBER

M1.1



GROUND FLOOR PLAN - UNIT B - HVAC

1/8" = 1'-0"

PLAN NOTES

A. SEE SHEET M1.0 FOR HVAC GENERAL NOTES AND SYMBOL LEGEND.

B. SEE SHEET SERIES M1.X FOR HVAC NEW WORK FLOOR PLANS.

C. SEE SHEET SERIES M2.X FOR HVAC DETAILS.

D. SEE SHEET M3.0 FOR HVAC TEMPERATURE CONTROLS.

E. SEE SHEET SERIES M4.X FOR HVAC SCHEDULES.

F. SEE SHEET SERIES M5.X FOR VRV FLOW DIAGRAMS PIPING AND WIRING

G. SEE DIFFUSER CONNECTION DETAIL FOR SIZE OF DUCT RUNOUTS TO DIFFUSERS, REGISTERS AND GRILLES AND DAMPERING REQUIREMENTS. DAMPERING REQUIREMENTS SHALL APPLY TO ALL SUPPLY AIR DUCT RUNOUTS TO ALL DIFFUSERS AND GRILLES WHETHER SHOWN ON FLOOR PLANS OR NOT. INSTALL DAMPERS AS CLOSE TO MAINS AS POSSIBLE IN ACCESSIBLE LOCATIONS.

H. H.C. TO INSTALL ADDITIONAL OFFSETS IN DUCTWORK AS REQUIRED TO INSTALL DUCTWORK TIGHT TO BOTTOM OF STEEL.

I. REFER TO ARCHITECTURAL REFLECTED CEILING PLANS FOR FINAL DIFFUSER AND GRILLE LAYOUTS.

J. MINIMIZE REFRIGERANT PIPING TRANSITIONS TO AVOID EXCEEDING MANUFACTURER'S MAXIMUM ALLOWABLE PIPING LENGTHS. TRANSITION DUCTWORK AND OTHER MECHANICAL COMPONENTS AROUND REFRIGERANT PIPING.

CODED NOTES

1. LINE 14"x12" EA DUCT WITH 1" INTERNAL LINING. SEE SPECIFICATIONS FOR LINING REQUIREMENTS.

2. WALL MOUNTED THERMOSTAT. TYPICAL.

3. VRV CONDENSING UNIT ON LOW ROOF ABOVE. MOUNT ON 18" EQUIPMENT RAILS AND VIBRATION ISOLATORS. SEE EQUIPMENT RAIL DETAIL. SEE PIPE CURB DETAIL FOR REQUIREMENTS FOR PIPING PENETRATING ROOF TO SERVE CONDENSING UNIT. SEE SCHEDULE FOR SIZE/MODEL REQUIREMENTS BASED ON ALTERNATE ACCEPTANCE. COORDINATE ROUTING REQUIREMENTS WITH FLOW DIAGRAMS AND MANUFACTURER.

4. RETURN AIR BOOT. SEE DETAIL. TYPICAL.

5. TRANSFER AIR DUCTWORK. TYPICAL.

6. ELECTRIC BASEBOARD HEAT. TYPICAL.

7. CEILING CASSETTE VRV INDOOR UNIT. BALANCE TO OUTSIDE AIR CFM INDICATED. SEE FLOW DIAGRAMS FOR REFRIGERANT PIPING REQUIREMENTS. TYPICAL.

8. EA DUCT UP TO EF-2 ON ROOF ABOVE. TRANSITION TO FAN INLET AS REQUIRED.

9. SUPPLY DUCTWORK IN BREAK ROOM TO HAVE 1" FLEXIBLE ELASTOMERIC INSULATION.

10. ELECTRIC WALL HEATER. SEE DETAIL FOR INSTALLATION INSTRUCTIONS. TYPICAL.

11. INSTALL VRV BRANCH SELECTOR BOX ABOVE CEILING. COORDINATE ROUTING REQUIREMENTS WITH VRV FLOW DIAGRAMS. TYPICAL.

12. WALL MOUNTED CO2 SENSOR. SEE TEMPERATURE CONTROL DRAWING M3.1.

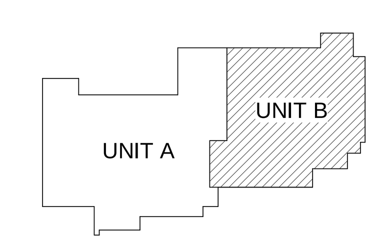
13. 1-1/2 HOUR RATED TYPE B FIRE DAMPER. TYPICAL.

14. DUCTED VRV INDOOR UNIT. BALANCE TO OUTSIDE AIR CFM INDICATED. SEE FLOW DIAGRAMS FOR REFRIGERANT PIPING REQUIREMENTS. TYPICAL.

15. 30" X 24" S.A. DUCTWORK TO CONNECT TO MAU-2.

ROOM LEGEND

100	SECURE VESTIBULE
101	RECEPTION/ WAITING
102	PUBLIC MEETING
103	PRE-FUNCTION
104	CLERK COUNTER
105	PUBLIC TLT.
106	VEST.
107	INTERVIEW ROOM
108	ELEC.
109	WORK ROOM
110	TRAINING/ COMMUNITY ROOM
111	CORR.
112	JAN.
113	MEN
114	WOMEN
115	STAFF BREAK ROOM
116	CONFERENCE ROOM
117	STOR.
118	KITCHENETTE
119	A/V CLOSET
120	TRAINING/ COMM. STORAGE
121	SHERIFF OFFICE
122	CORR.
123	TRAINING LIEUTENANT OFFICE
124	CAPTAIN OFFICE
125	CAPTAIN OFFICE
126	CAPTAIN OFFICE
127	CAPTAIN OFFICE
128	CHIEF DEPUTY OFFICE
129	DETECTIVE OFFICE
130	INVESTIG. SUPPLY STORAGE
131	DETECTIVE OFFICE
132	INVESTIG. FILE STORAGE
133	DETECTIVE OFFICE
134	ADMIN. ASSISTANT
135	DETECTIVE OFFICE
136	INTERVIEW ROOM
137	DETECTIVE OFFICE
138	INTERVIEW ROOM
139	SARGENT OFFICE
140	CORR.
141	CHIEF DETECTIVE OFFICE
142	CORR.
143	CORR.
144	RECORDS ROOM
145	FITNESS TRAINING
146	PHYS. TACTICS TRAINING & GEAR



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PROJECT

RALEIGH COUNTY SHERIFF'S DEPARTMENT

OWNER

RALEIGH COUNTY COMMISSION

LOCATION

BECKLEY, WV

REVISIONS

DATE

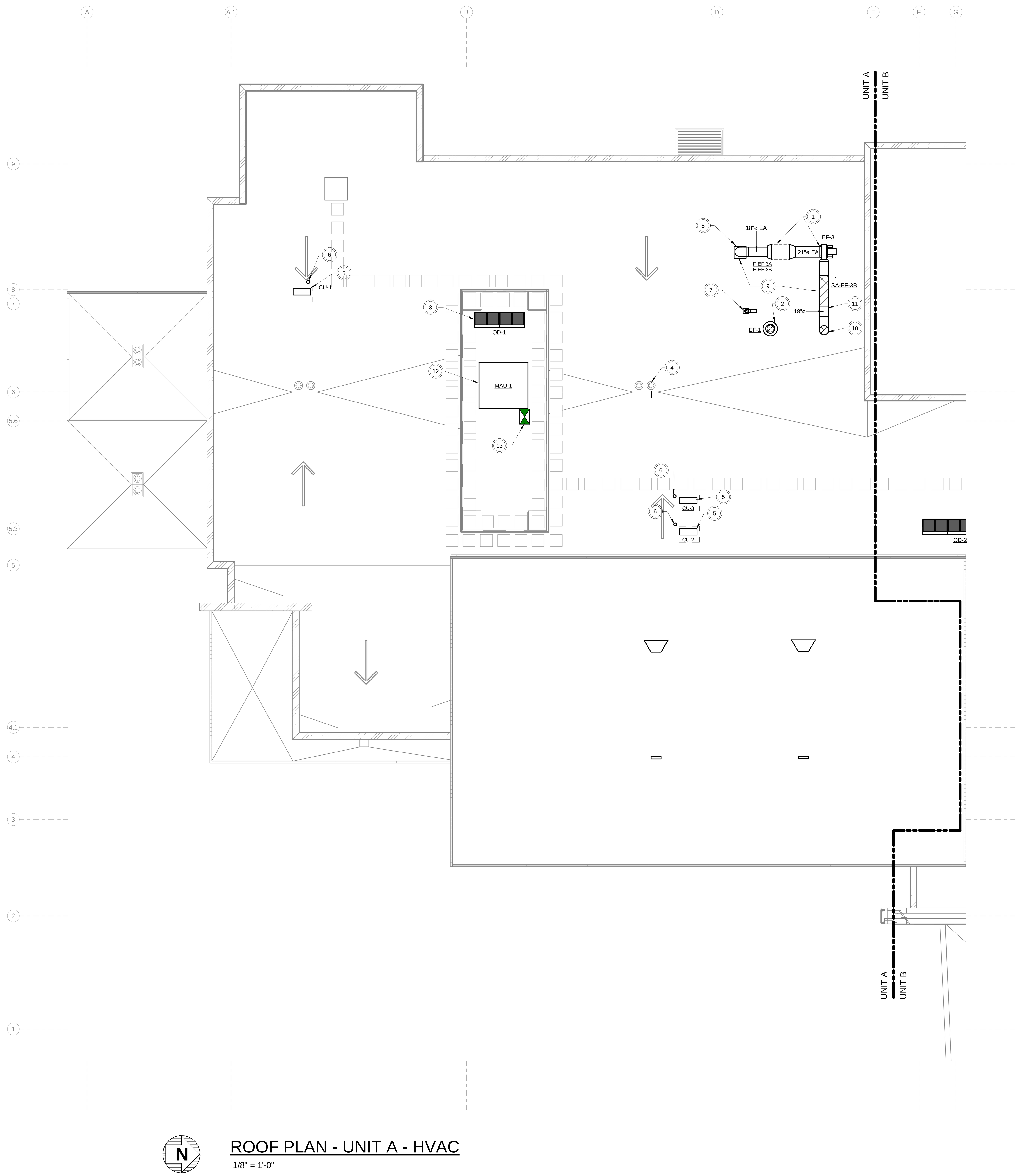
3/01/2022

TITLE

GROUND FLOOR PLAN - UNIT B - HVAC

DRAWING NUMBER

M1.2



ROOF PLAN - UNIT A - HVAC

1/8" = 1'-0"

PLAN NOTES

A. SEE SHEET M1.0 FOR HVAC GENERAL NOTES AND SYMBOL LEGEND.

B. SEE SHEET SERIES M1.X FOR HVAC NEW WORK FLOOR PLANS.

C. SEE SHEET SERIES M2.X FOR HVAC DETAILS.

D. SEE SHEET M3.0 FOR HVAC TEMPERATURE CONTROLS.

E. SEE SHEET SERIES M4.X FOR HVAC SCHEDULES.

F. SEE SHEET SERIES M5.X FOR VRV FLOW DIAGRAMS PIPING AND WIRING

G. ADJUST ORIENTATION OF ALL ROOF CURBS WITH SLOPE ROOF TO KEEP EQUIPMENT LEVEL.

CODED NOTES

1. BAG-IN BAG-OUT FILTER BANK WITH ASSOCIATED UTILITY SET FAN. SEE DETAIL FOR FAN AND FILTER INSTALLATION INSTRUCTIONS.

2. EXHAUST FAN. SEE "ROOF CENTRIFUGAL EXHAUST FAN DETAIL" FOR INSTALLATION INSTRUCTIONS.

3. VRV OUTDOOR CONDENSING UNIT. MOUNT ON 18" EQUIPMENT RAILS AND VIBRATION ISOLATORS. SEE EQUIPMENT RAIL DETAIL.

4. TERMINATE 2" CONDENSATE PIPING OVER ROOF DRAIN. AVOID INTERFERENCE WITH ROOFTOP UNIT ACCESS DOOR CLEARANCES WHEN ROUTING. SUPPORT ROOF MOUNTED PIPING WITH PREMANUFACTURERED PIPING SUPPORTS. SEE SPECIFICATIONS FOR SPACING REQUIREMENTS.

5. SPLIT SYSTEM OUTDOOR CONDENSING UNIT. INSTALL CONDENSING UNIT ON "PATE" MODEL ES-1B TYPE EQUIPMENT RAILS. SECURE RAILS TO ROOF DECK AND SECURE CONDENSING UNIT TO EQUIPMENT RAILS AS REQUIRED. SEE "EQUIPMENT RAIL DETAIL". EXTEND RS AND RL PIPING TO CONDENSING UNIT AND CONNECT AS REQUIRED. VERIFY REFRIGERANT PIPE SIZES AND MAX LENGTHS WITH MANUFACTURER PRIOR TO INSTALLATION. MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES. TYPICAL.

6. RL/RS PIPING UP THROUGH ROOF. SUPPORT ROOF MOUNTED PIPING WITH PREMANUFACTURERED PIPING SUPPORTS IF ROOF MOUNTED PIPING IS NECESSARY. ROOF MOUNTED SUPPORTS TO BE "PHP" PIPE SUPPORTS OR APPROVED EQUAL. PROVIDE TYPE PP10 WITH ROLLER. SEE SPECIFICATIONS FOR SPACING REQUIREMENTS. SEE PIPE CURB DETAIL FOR ROOF PENETRATION REQUIREMENTS.

7. 6" DRYER EXHAUST TERMINATION ABOVE ROOF. INSTALL DUCT CURB AND SEAL AIR AND WATER TIGHT AT ROOF PENETRATION. TERMINATE WITH 90 DEG ELBOW AND DRYER EXHAUST BACKDRAFT DAMPER.

8. 18" DIAMETER EA DUCT DOWN THROUGH ROOF. SEE DETAILS FOR PENETRATION REQUIREMENTS.

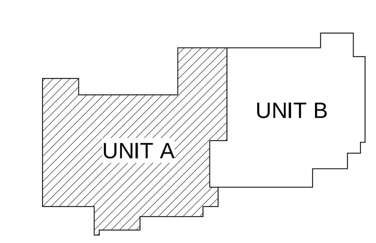
9. SLOPE TOP OF ROOFTOP DUCTWORK. BUILD SHEETMETAL TRIANGULAR ANGLE CAP ON SOUND ATTENUATOR.

10. TERMINATE DUCTWORK PER EVIDENCE ROOM EXHAUST UTILITY EXHAUST FAN DETAIL - PLAN VIEW - VERTICAL TERMINATION APPROX 2' ABOVE ADJACENT ROOF. PROVIDE 2" DRAIN AT BOTTOM OF STACK WITH P-TRAP. TERMINATE DRAIN OVER ROOF. SEE P-TRAP DETAIL FOR SIZING (BLOWTHROUGH).

11. SEE ROOF MOUNTED ROUND DUCT SUPPORT DETAIL FOR DUCT SUPPORTS. SEE SPECIFICATIONS FOR SPACING REQUIREMENTS.

12. DEDICATED OUTSIDE AIR UNIT MAU-1. MOUNT UNIT ON 4" CONCRETE HOUSEKEEPING PAD. EXTEND PIPING TO COILS AS NOTED. EXTEND 1-1/4" A/C CONDENSATE PIPING FROM UNIT COOLING COIL DRAIN CONNECTION AND 3/4" DRAIN FROM ENERGY RECOVERY COIL SECTION TO NEARBY ROOF DRAIN. SEE UNIT ELEVATION.

13. 30" x 20" S.A. DUCTWORK FROM CEILING SPACE BELOW TO CONNECT TO MAU-1.



KEY PLAN

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PROJECT

RALEIGH COUNTY SHERIFF'S DEPARTMENT

OWNER

RALEIGH COUNTY COMMISSION

LOCATION

BECKLEY, WV

REVISIONS

DATE

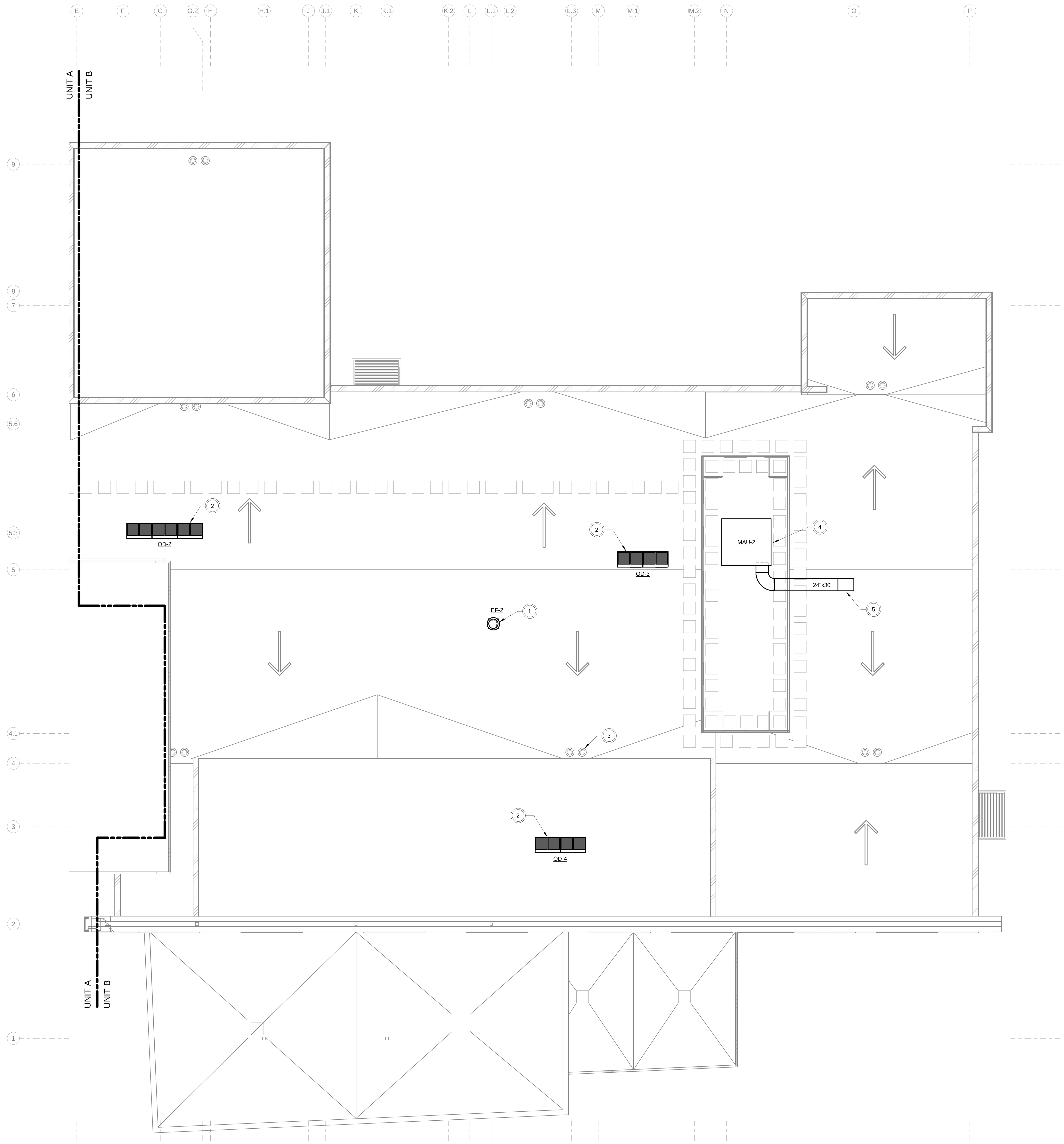
3/01/2022

TITLE

ROOF PLAN - UNIT A - HVAC

DRAWING NUMBER

M1.3



ROOF PLAN - UNIT B - HVAC

1/8" = 1'-0"

PLAN NOTES

A. SEE SHEET M1.0 FOR HVAC GENERAL NOTES AND SYMBOL LEGEND.

B. SEE SHEET SERIES M1.X FOR HVAC NEW WORK FLOOR PLANS.

C. SEE SHEET SERIES M2.X FOR HVAC DETAILS.

D. SEE SHEET M3.0 FOR HVAC TEMPERATURE CONTROLS.

E. SEE SHEET SERIES M4.X FOR HVAC SCHEDULES.

F. SEE SHEET SERIES M5.X FOR VRV FLOW DIAGRAMS PIPING AND WIRING

G. ADJUST ORIENTATION OF ALL ROOF CURBS WITH SLOPE ROOF TO KEEP EQUIPMENT LEVEL.

CODED NOTES

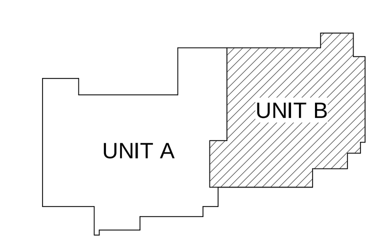
1. EXHAUST FAN. SEE "ROOF CENTRIFUGAL EXHAUST FAN DETAIL" FOR INSTALLATION INSTRUCTIONS.

2. VRV OUTDOOR CONDENSING UNIT. MOUNT ON 18" EQUIPMENT RAILS AND VIBRATION ISOLATORS. SEE EQUIPMENT RAIL DETAIL.

3. TERMINATE 2" CONDENSATE PIPING OVER ROOF DRAIN. AVOID INTERFERENCE WITH ROOFTOP UNIT ACCESS DOOR CLEARANCES WHEN ROUTING. SUPPORT ROOF MOUNTED PIPING WITH PREMANUFACTURERED PIPING SUPPORTS. SEE SPECIFICATIONS FOR SPACING REQUIREMENTS.

4. DEDICATED OUTSIDE AIR UNIT MAU-2. MOUNT UNIT ON 4" CONCRETE HOUSEKEEPING PAD. EXTEND PIPING TO COILS AS NOTED. EXTEND 1-1/4" A/C CONDENSATE PIPING FROM UNIT COOLING COIL DRAIN CONNECTION AND 3/4" DRAIN FROM ENERGY RECOVERY COIL SECTION TO NEARBY ROOF DRAIN. SEE UNIT ELEVATION.

5. 30" x 24" S.A. DUCTWORK FROM CEILING SPACE BELOW TO CONNECT TO MAU-2.



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DATE

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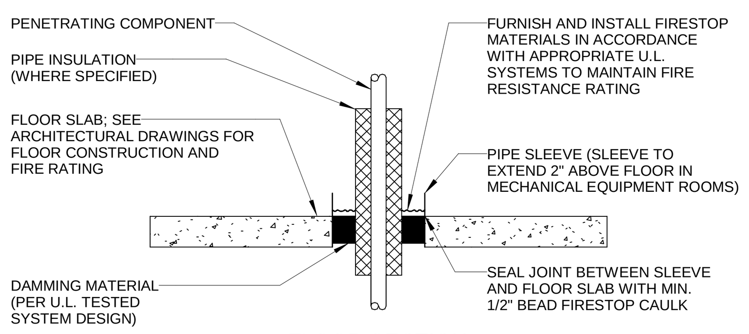
TITLE

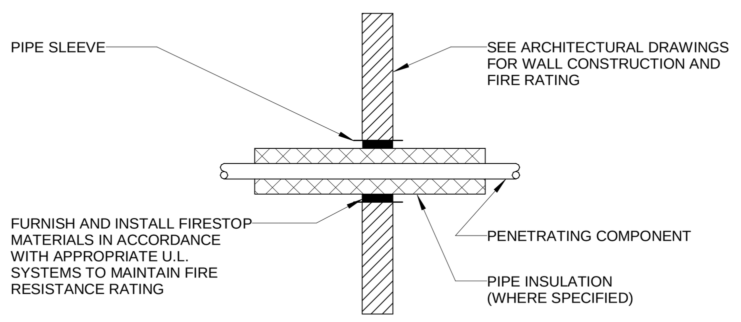
ROOF PLAN - UNIT B - HVAC

DRAWING NUMBER

M1.4



FLOOR SECTION



WALL SECTION

NOTES:

1. WHERE PIPES, DUCTS AND OTHER COMPONENTS PASS THROUGH FIRE OR SMOKE RATED WALLS OR FLOORS, PROVIDE NON-ASBESTOS SEAL ASSEMBLIES CLASSIFIED BY U.L. TO PROVIDE FIRE BARRIERS EQUAL TO OR GREATER THAN THE TIME RATING OF THE CONSTRUCTION BEING PENETRATED, WITH APPROPRIATE MATERIALS AND SYSTEMS THAT COMPLY WITH APPLICABLE CODES AND THAT HAVE BEEN TESTED IN ACCORDANCE WITH U.L. 1479 OR ASTM E814.

2. GROUT, MORTAR OR GYPSUM BASED PRODUCTS SHALL NOT BE INSTALLED IN LIEU OF FIRESTOPPING MATERIALS AND U.L. SYSTEMS.

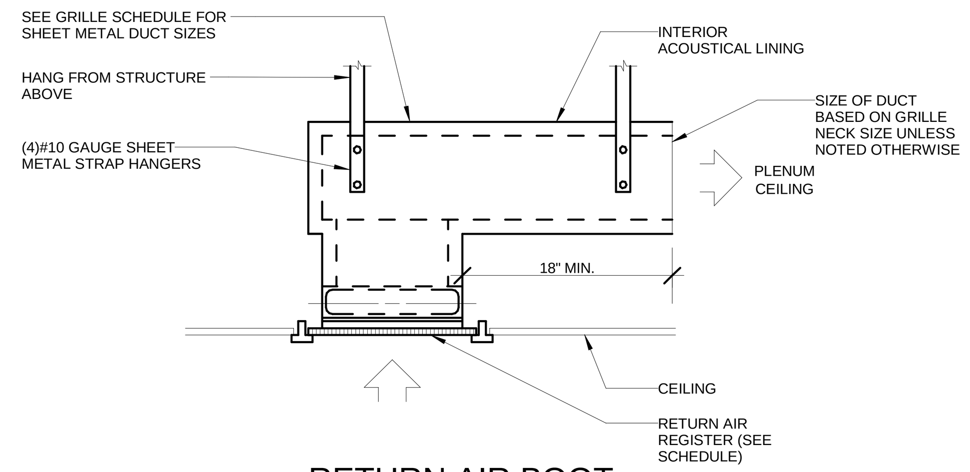
3. FOR SLEEVED PENETRATIONS, FIRESTOP ANNULAR SPACE, IF ANY, BETWEEN SLEEVE AND ADJACENT CONSTRUCTION TO MEET U.L. SYSTEM REQUIREMENTS. SEE NOTE 2 ABOVE.

4. THIS CONTRACTOR SHALL FIRESTOP ALL MISCELLANEOUS OPENINGS IN FIRE-RATED CONSTRUCTION RESULTING FROM HIS WORK.

5. CONTRACTOR SHALL PROVIDE SUBMITTAL DRAWINGS TO ENGINEER, INCLUDING U.L. RATED SYSTEM NUMBER AND DETAIL FOR EACH TYPE OF PENETRATION AND CONFIGURATION.

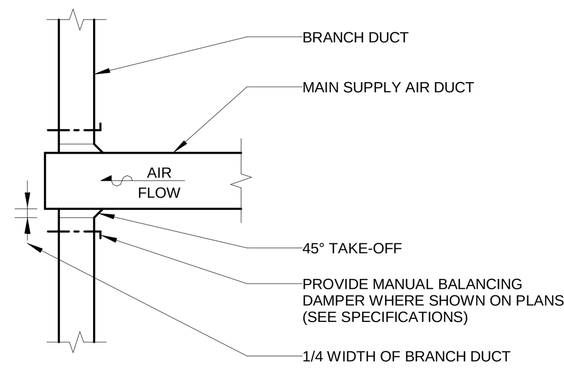
FIRESTOPPING DETAIL FOR PENETRATIONS THROUGH FIRE-RATED CONSTRUCTIONS

N.T.S.



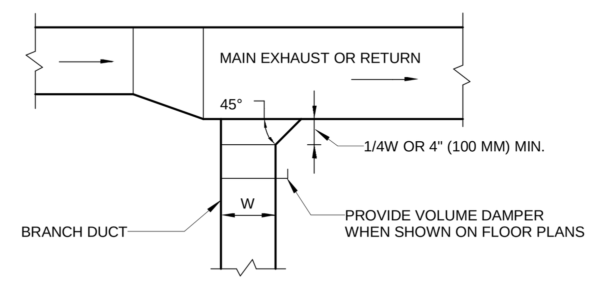
RETURN AIR BOOT

N.T.S.



LOW PRESSURE END OF SUPPLY AIR DUCT DETAIL

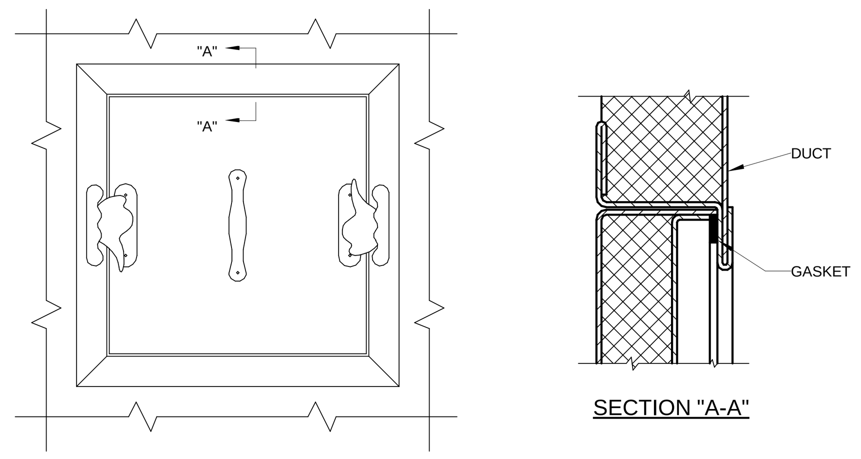
N.T.S.



PLAN VIEW

EXHAUST OR RETURN BRANCH DUCTWORK

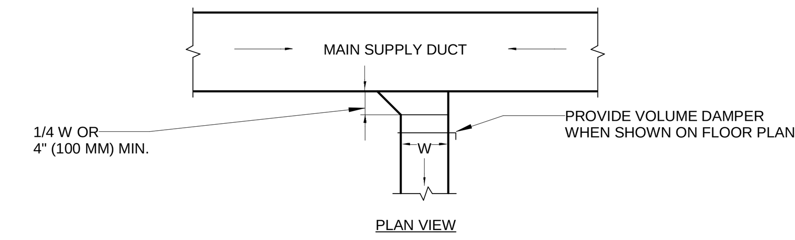
N.T.S.



SECTION "A-A"

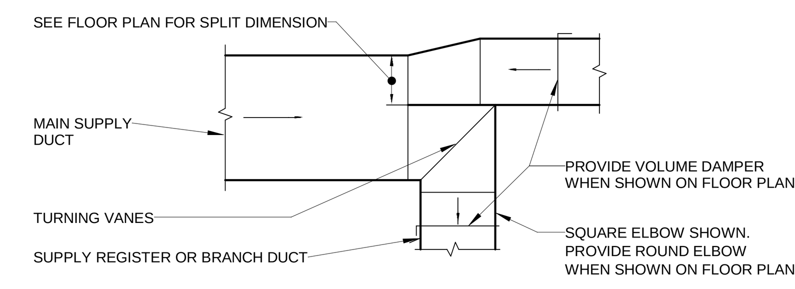
ACCESS PANEL

N.T.S.



PLAN VIEW

BRANCH DUCT TAKE-OFF

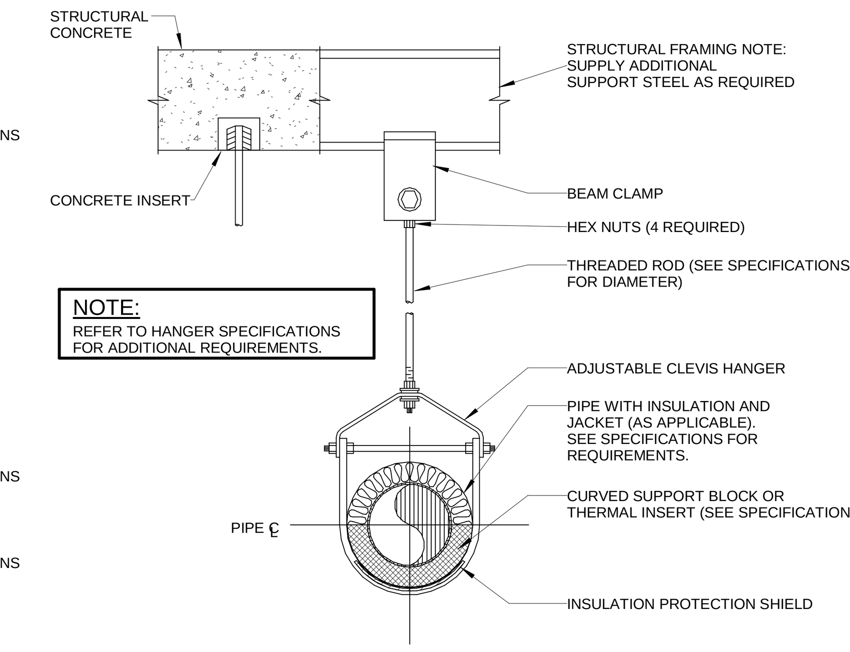


PLAN VIEW

AIR SPLIT DUCT TAKE-OFF

SUPPLY DUCTWORK TAKE-OFFS

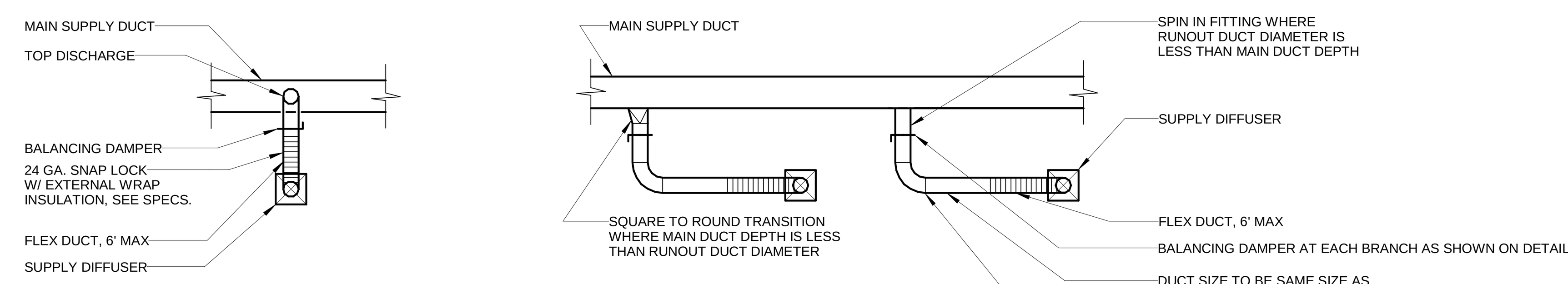
N.T.S.



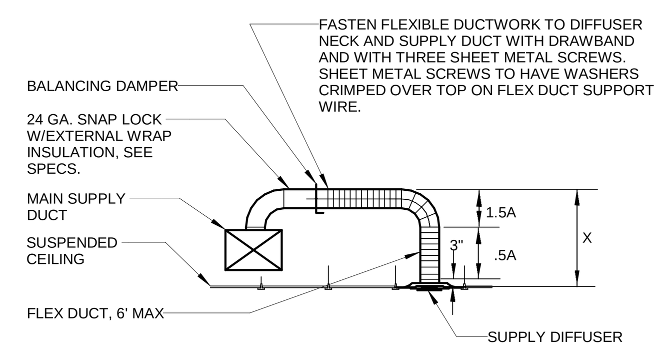
(FOR MEDIUM LOWER THAN AMBIENT TEMPERATURE)

CLEVIS HANGER PIPE SUPPORT

N.T.S.



DETAILED REPRESENTATION - PLAN VIEWS

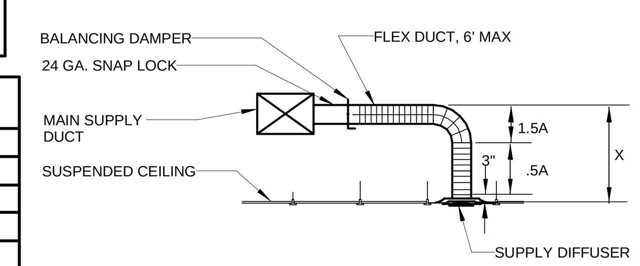


TOP DISCHARGE

DUCT RUNOUT SIZE SHALL BE THE SAME SIZE AS THE DIFFUSER NECK SIZE UNLESS NOTED OTHERWISE (TYP).

DIFF. NECK DIA. A	X
6"	15"
8"	19"
10"	23"
12"	27"
14"	31"
15"	35"

A = DIFFUSER NECK DIA.
X = 3" + 2A (MINIMUM)



SIDE DISCHARGE

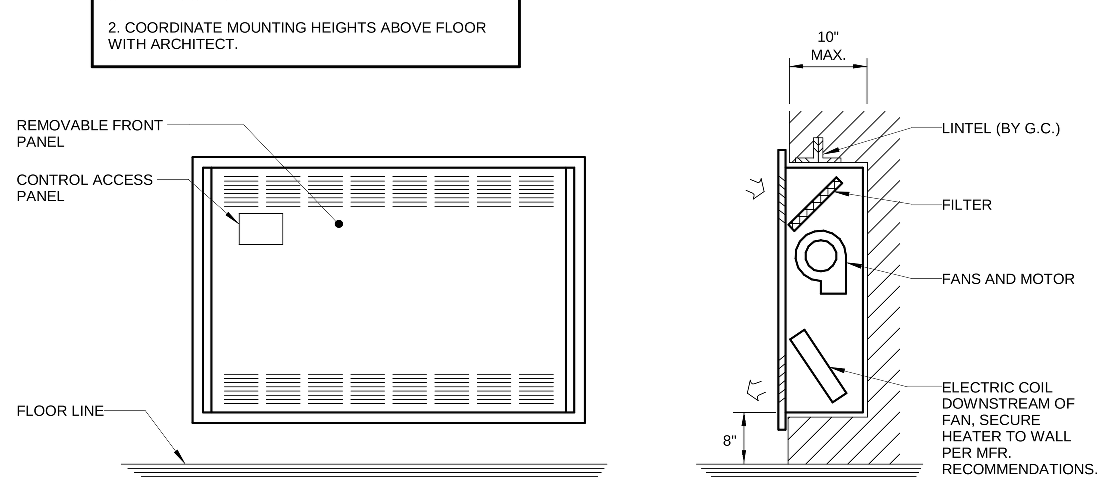
SUPPLY DIFFUSER CONNECTION DETAIL

N.T.S.

NOTES:

1. COORDINATE CUH AIRFLOW ORIENTATION WITH SELECTED UNITS.

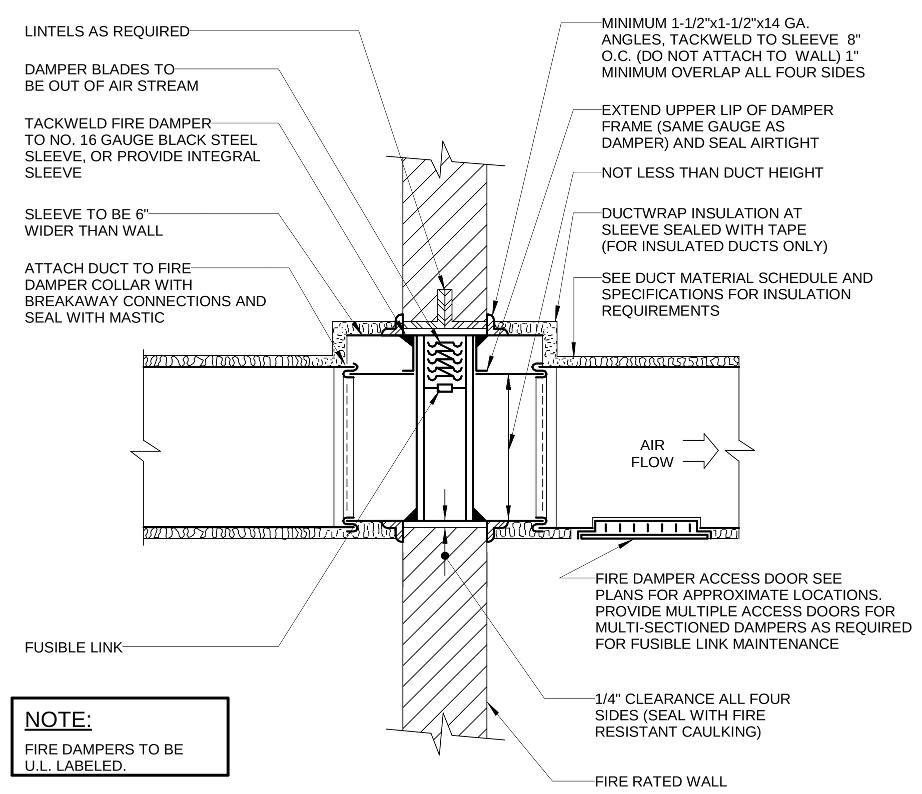
2. COORDINATE MOUNTING HEIGHTS ABOVE FLOOR WITH ARCHITECT.



ELECTRIC - FULLY RECESSED

CABINET HEATER - WALL MOUNTED

N.T.S.

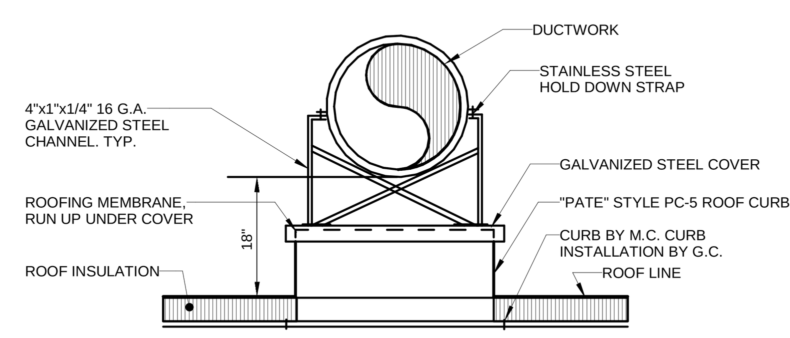


NOTE:
FIRE DAMPERS TO BE U.L. LABELED.

WALL MOUNTED

TYPE B FIRE DAMPER

N.T.S.



ROOF MOUNTED ROUND DUCT SUPPORT

N.T.S.

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PROJECT

RALEIGH COUNTY SHERIFF'S DEPARTMENT

OWNER

RALEIGH COUNTY COMMISSION

LOCATION

BECKLEY, WV

REVISIONS

DATE

3/01/2022

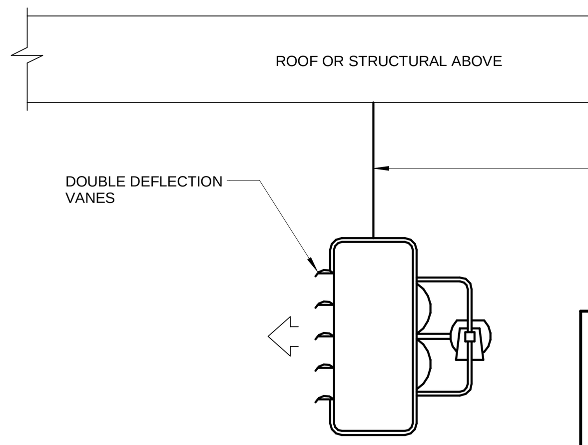
TITLE

DETAILS - HVAC

DRAWING NUMBER

M2.0

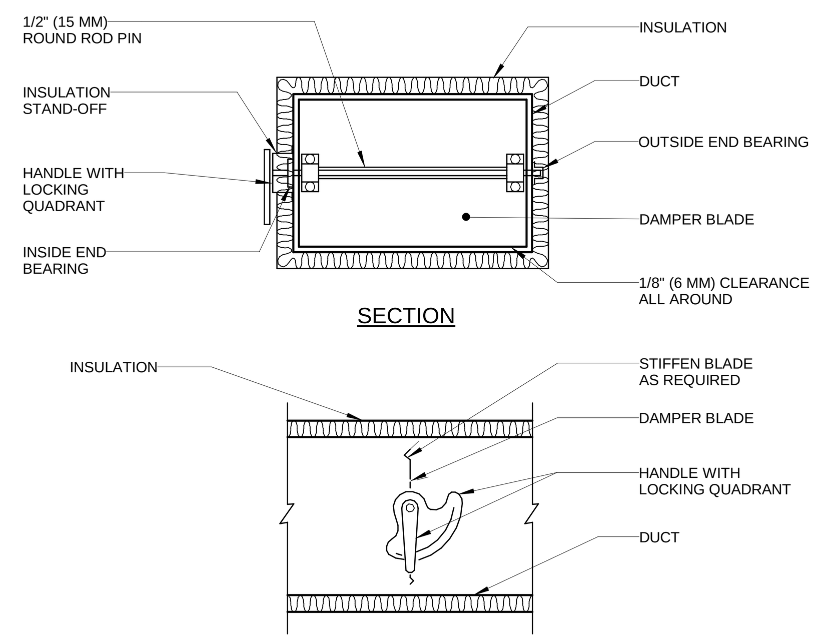
C:\Users\EFerguson\Documents\MEP_CENTRAL FILE_VRV_EFerguson.rvt 3/1/2022 10:21:56 AM



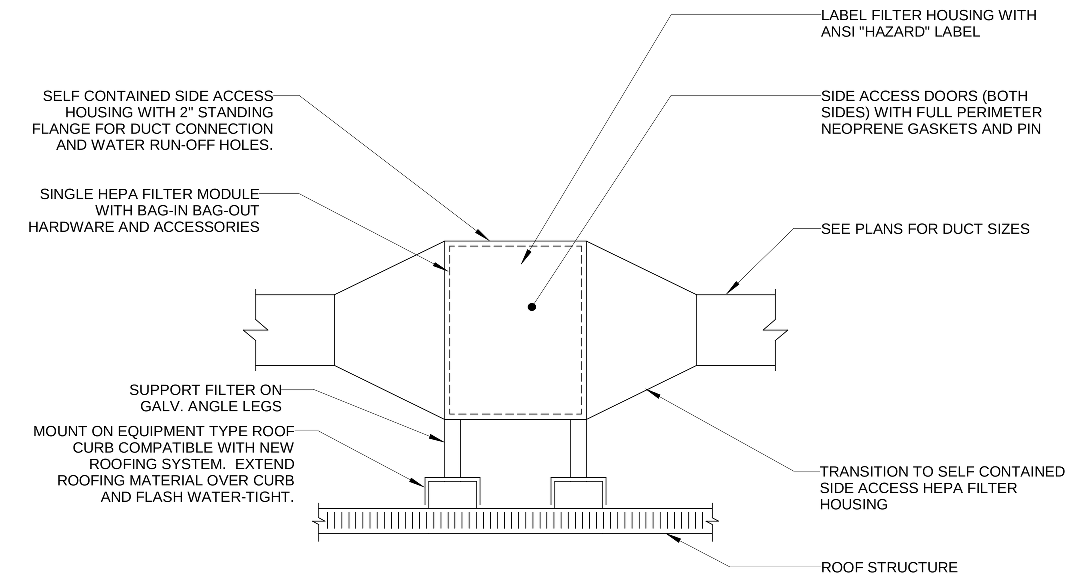
NOTE:
1. UTILIZE THREADED INSERTS FOR ALL HANGER REQUIREMENTS.
2. SEE FLOOR PLAN FOR UNIT INSTALLATION TYPE.

(ELECTRIC)
UNIT HEATER
N.T.S.

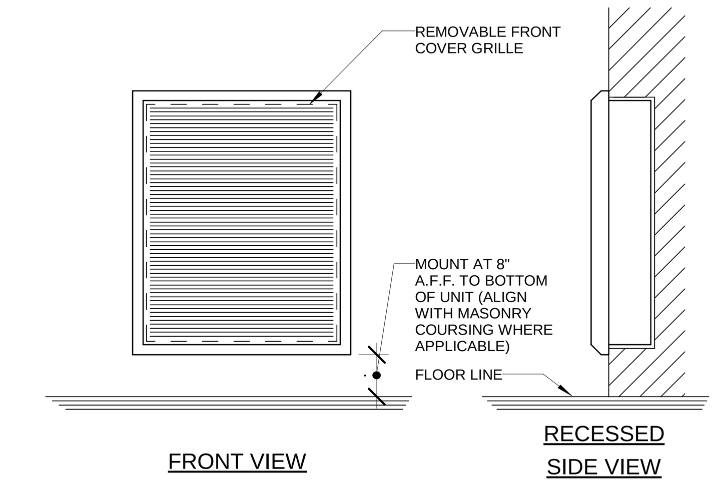
NOTE:
1. DELETE INSULATION STAND-OFF ON DUCTWORK WITHOUT EXTERIOR INSULATION.
2. DETAIL SHOWS SINGLE BLADE DAMPER. DAMPER INSTALLATION SHALL BE SIMILAR FOR MULTI-BLADE DAMPERS & ROUND DAMPERS.



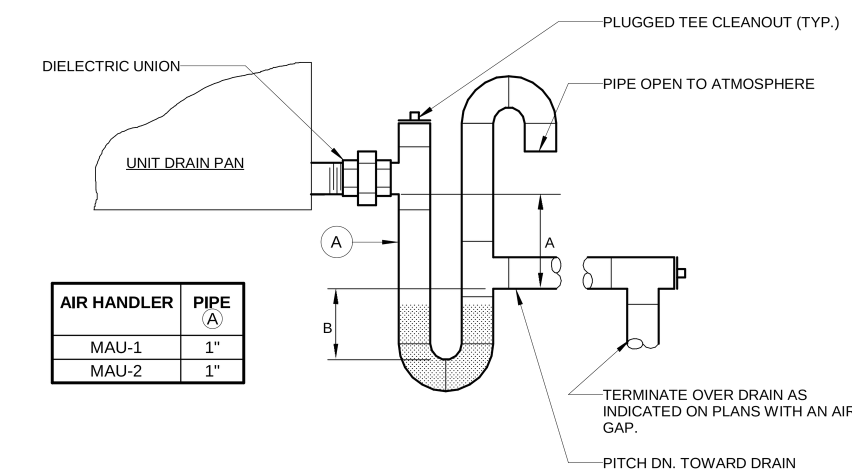
SIDE ELEVATION
VOLUME DAMPER DETAIL
N.T.S.



SELF CONTAINED HEPA FILTER DETAIL
N.T.S.



ELECTRIC WALL HEATER
N.T.S.



AIR HANDLER	PIPE (A)
MAU-1	1"
MAU-2	1"

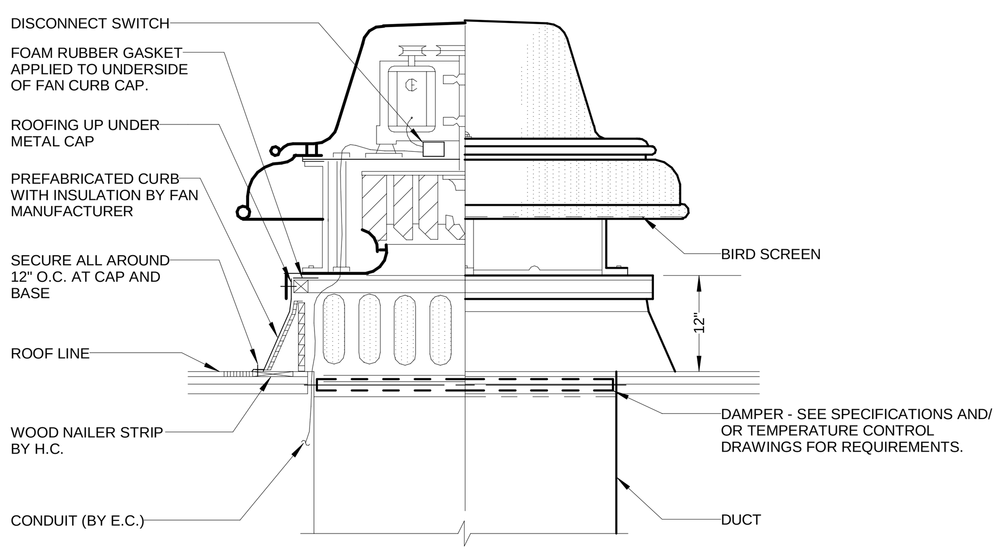
UNIT TYPE	A	B
DRAW THROUGH	X"+2"	X/2"
BLOW THROUGH	1" MINIMUM	X"+1"

WHERE X = POSITIVE VALUE OF STATIC PRESSURE DIFFERENCE BETWEEN PAN SECTION AND TRAP LOCATION

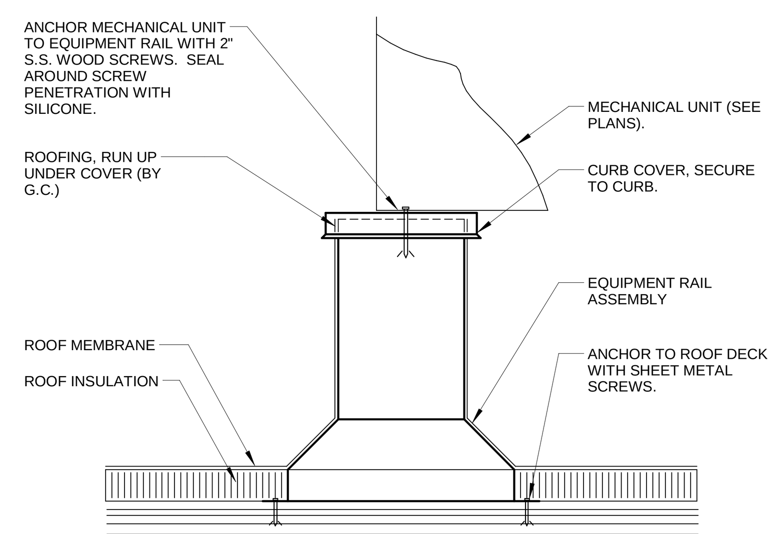
NOTES:
1. LOCATE TRAP AS CLOSE AS POSSIBLE TO AHU DRAIN OUTLET WITH BOTTOM BELOW SUPPORT STRUCTURE.
2. SIZE OF TRAP PIPING TO BE LARGER OF EQUIPMENT OUTLET SIZE OR DIMENSION ON PLANS.
3. SEE SPECIFICATIONS FOR INSULATION REQUIREMENTS
4. NOTIFY ENGINEER BEFORE FABRICATING IF PHYSICAL CONDITIONS PROHIBIT INSTALLATION OF DEPTH SHOWN.

STANDARD A/C CONDENSATE TRAP DETAIL
N.T.S.

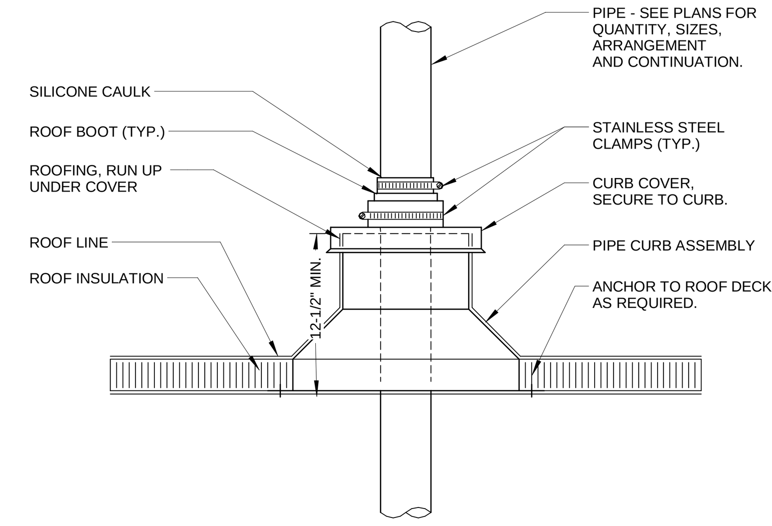
NOTES:
1. SHIM CURB AND VENTILATOR AS NECESSARY TO MOUNT EXHAUST FAN DEAD LEVEL.
2. SIZE ROOF OPENING IN ACCORDANCE WITH MFR'S APPROVED SHOP DRAWINGS. COORDINATE LOCATION WITH G.C.
3. CONDUIT TO BE RUN IN CORNER, INSIDE CURB BY E.C. UNLESS OTHERWISE INDICATED.



WITH SOUND CURB
ROOF CENTRIFUGAL EXHAUST FAN
N.T.S.

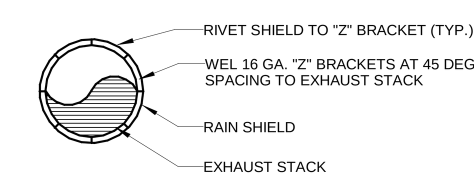


EQUIPMENT RAIL DETAIL
N.T.S.

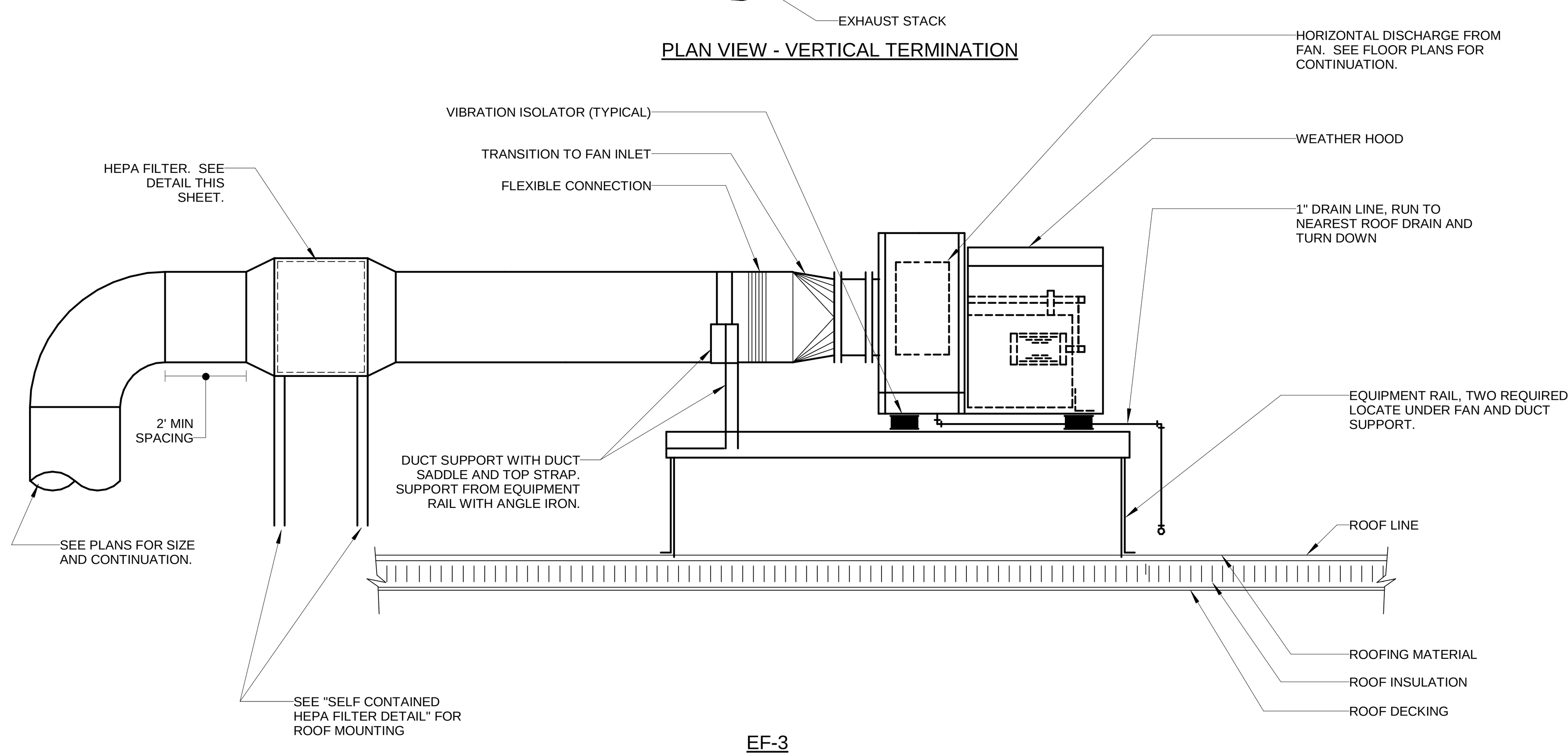


NOTE:
HEIGHT OF CURB TO BE COORDINATED WITH ROOF INSULATION THICKNESS TO MAINTAIN 8" EXTENSION ABOVE INSULATION.

PIPE CURB DETAIL
N.T.S.



PLAN VIEW - VERTICAL TERMINATION



EF-3
UTILITY EXHAUST FAN DETAIL
N.T.S.

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PROJECT
RALEIGH COUNTY SHERIFF'S DEPARTMENT

OWNER
RALEIGH COUNTY COMMISSION

LOCATION
BECKLEY, WV

REVISIONS

DATE
3/01/2022

TITLE
DETAILS - HVAC

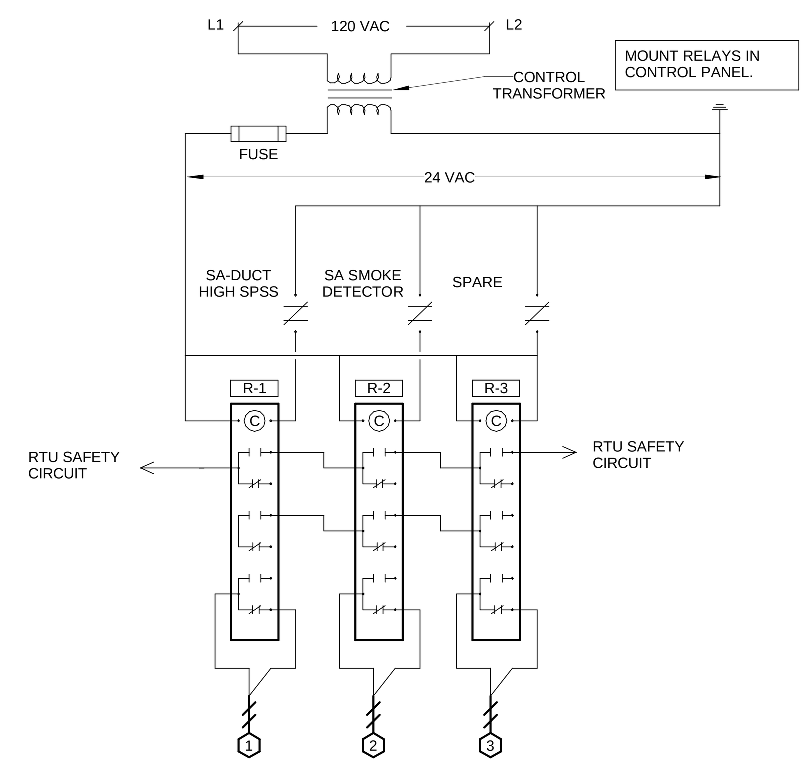
DRAWING NUMBER
M2.1

TEMPERATURE CONTROLS GENERAL NOTES

1. ALL EQUIPMENT RESETS FOR HVAC EQUIPMENT TO BE IN BUILDING AUTOMATION SYSTEM.
2. ENTIRE BUILDING TO BE ON EMERGENCY POWER.

TEMPERATURE CONTROL SYMBOL LEGEND

ABBREVIATION	DESCRIPTION	REMARKS
AFM-2	AIRFLOW MEASURING STATION - DUCT MOUNTED TYPE	LOCATE WHERE INDICATED ON PLANS PER MANUFACTURERS RECOMMENDATIONS. SEE SPECIFICATIONS.
CDS	CARBON DIOXIDE SENSOR (DIGITAL) WITH ASPIRATION KIT	EQUAL TO TELAIRE SYSTEMS 200/V-3/1502
CSR	CURRENT SENSING RELAY	
DA-12	NORMALLY CLOSED (N.C.) ELECTRIC TWO POSITION DAMPER ACTUATOR	SEE PLANS FOR VOLTAGE
D-4	PARALLEL BLADE LOW LEAKAGE INSULATED BLADE CONTROL DAMPER	
E.C.	ELECTRICAL CONTRACTOR	
FSD-1	DUCT SMOKE DETECTOR WITH AUXILIARY CONTACT	BY E.C.
Ⓖ	MAGNEHELIC PRESSURE GAUGE	SEE SPECIFICATIONS
H-1	DUCT HUMIDITY SENSOR	
H-2	SPACE HUMIDITY SENSOR (WITHOUT LOCAL ADJUSTABLE SET POINT)	
MFR.	MANUFACTURER	
N.C.	NORMALLY CLOSED	
N.O.	NORMALLY OPEN	
ΔP	DIFFERENTIAL PRESSURE SENSOR FOR AIRFLOW (BINARY)	
SPS-1	STATIC PRESSURE SENSOR FOR AIRFLOW (ANALOG)	
SPS-3	STATIC PRESSURE SENSOR FOR AIRFLOW - LOW LIMIT - (ANALOG)	
T-1	DUCT TEMPERATURE SENSOR	
T-2	OUTDOOR AIR TEMPERATURE SENSOR	SHIELDED
T-3	ROOM TEMPERATURE SENSOR (WITH LOCAL ADJUSTABLE SET POINT)	
T-6	PIPE INSERTION LIQUID TEMPERATURE SENSOR	
T.C.C.	TEMPERATURE CONTROL CONTRACTOR	
VFD	VARIABLE FREQUENCY DRIVE (FOR MOTOR SPEED ADJUSTMENT)	SEE SCHEDULES
VPS-1	VELOCITY PRESSURE SENSOR	FURNISHED WITH AIRFLOW MEASURING STATION



MAU-1 AND MAU-2

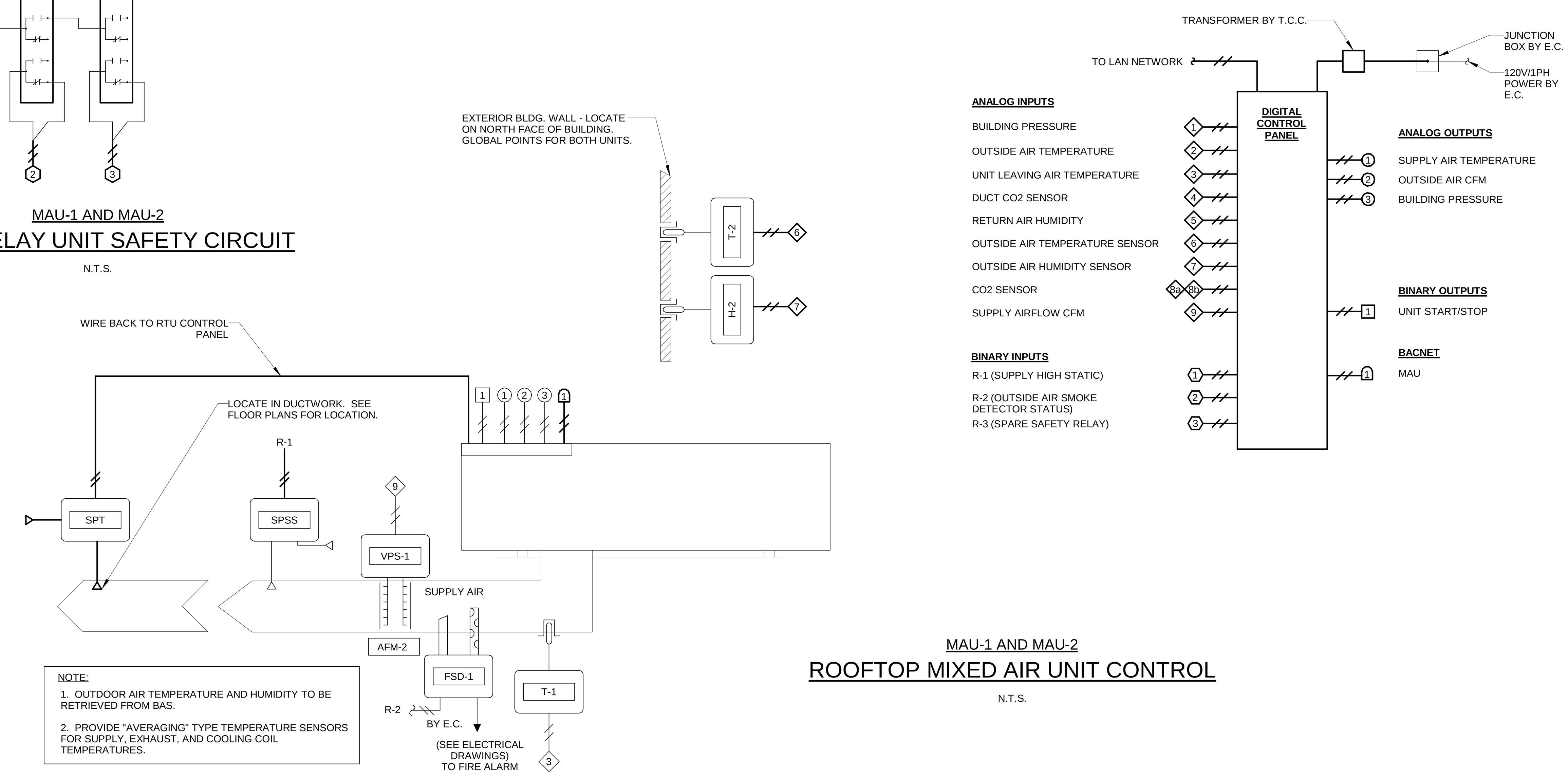
PILOT RELAY UNIT SAFETY CIRCUIT

N.T.S.

MAU-1 AND MAU-2 SEQUENCE OF OPERATIONS

A. DESCRIPTION: THESE AIR HANDLING UNITS ARE CONSTANT AIR VOLUME AIR HANDLERS WITH A MODULATING GAS FIRED FURNACE, DX COOLING COIL, AND SUPPLY FANS.
B. UNIT IS NORMALLY STARTED AND STOPPED BY THE BAS OR MANUALLY AT THE UNIT.
C. THE UNIT SHALL BE OFF DURING ANY UNOCCUPIED CYCLE.
D. WHEN THE UNIT IS OFF, THE OUTSIDE AIR DAMPER SHALL BE CLOSED.
E. THE UNIT'S SUPPLY FANS ARE CONSTANT VOLUME.
F. UNOCCUPIED MODE OPERATION:
   1. MAKE UP AIR UNITS SHALL BE OFF.
G. OCCUPIED MODE OPERATION:
   1. FAN CONTROL:
      a. THE UNIT'S SUPPLY FANS SHALL RUN CONTINUOUSLY DURING ANY OCCUPIED CYCLE.
      b. SUPPLY FAN SHALL RUN AT FULL SCHEDULED AIRFLOW DURING OCCUPIED CYCLE.
   2. COOLING/HEATING CONTROL:
      a. THE UNIT'S CONTROLLER SHALL MODULATE THE UNIT'S DAMPERS, GAS FURNACE AND DIGITAL SCROLL COMPRESSORS AS REQUIRED TO MAINTAIN DISCHARGE AIR TEMPERATURE.
   3. SMOKE DETECTION: WHEN SMOKE IS DETECTED, THE SUPPLY AND RELIEF FAN SHALL SHUT OFF AND AN ALARM SHALL BE TRANSMITTED TO THE FIRE ALARM SYSTEM AND TO THE FACILITY MANAGEMENT SYSTEM.

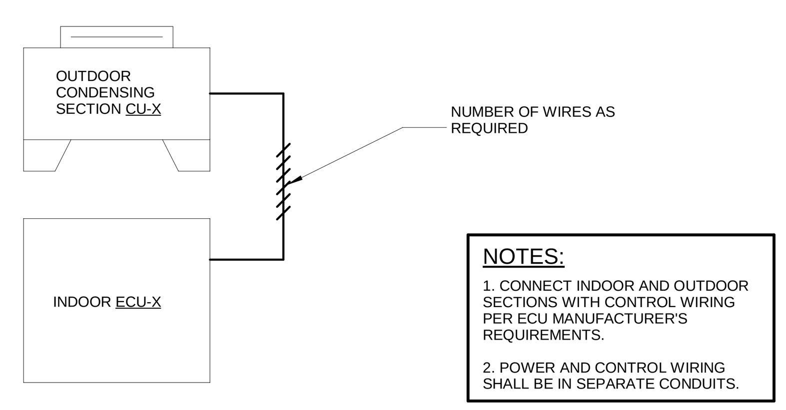
H. PROGRAM AT MINIMUM THE FOLLOWING ALARMS:
   1. SUPPLY FAN FAILURE
   2. SUPPLY FAN VFD ALARM
   3. FREEZESTAT ALARM
   4. DIRTY PRE-FILTER
   5. SMOKE DETECTOR ALARM
   6. HIGH SUPPLY AIR TEMPERATURE
   7. HIGH SPACE TEMPERATURE
   8. LOW SPACE TEMPERATURE
   9. HIGH SPACE HUMIDITY
   10. SUPPLY FAN HIGH STATIC CUTOUT



MAU-1 AND MAU-2

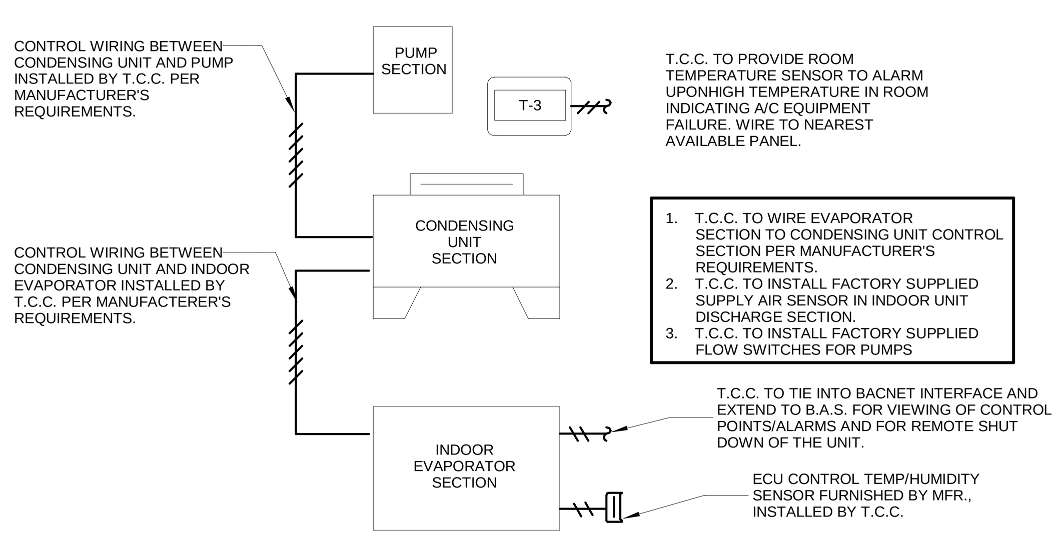
ROOFTOP MIXED AIR UNIT CONTROL

N.T.S.



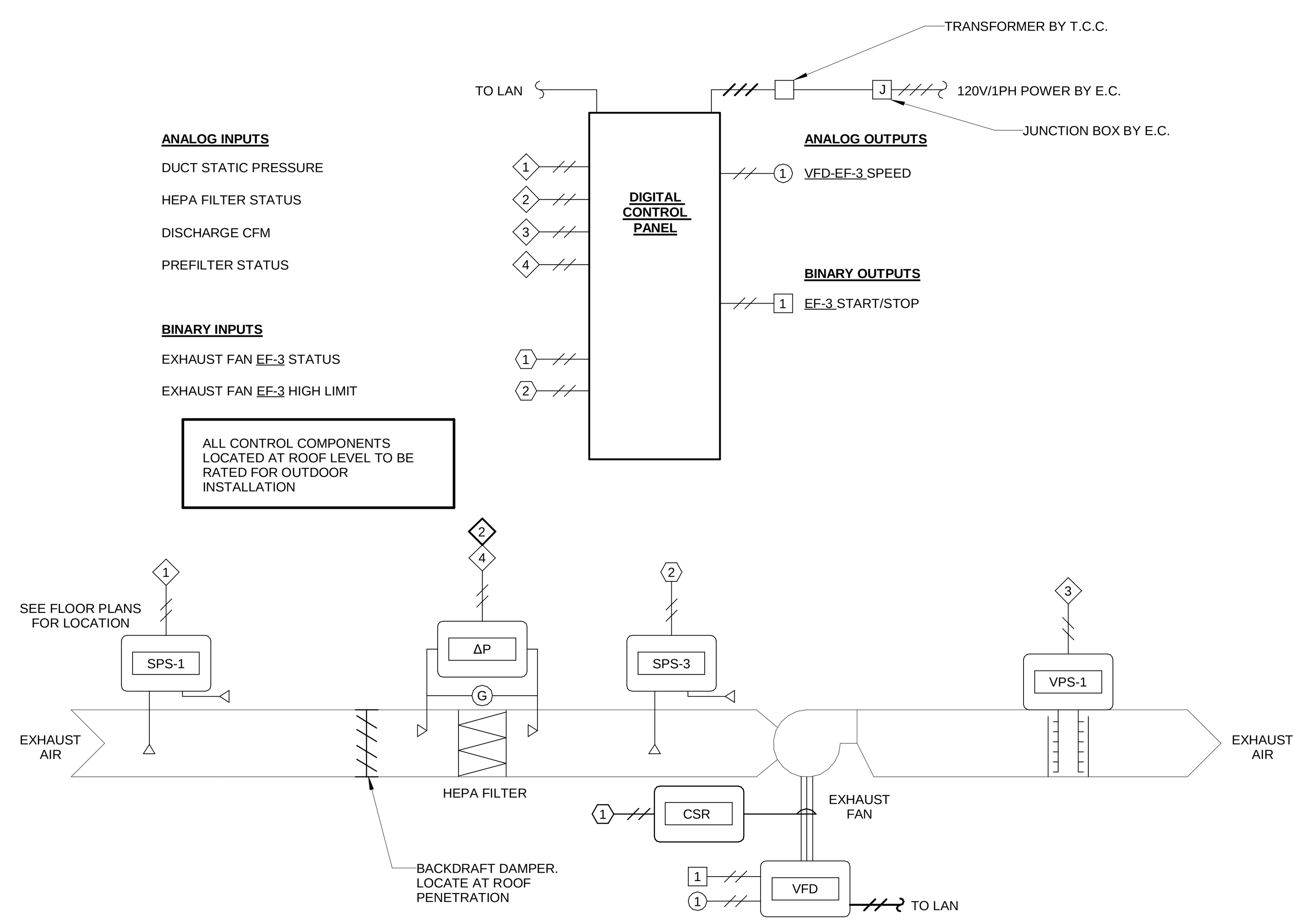
ENVIRONMENTAL CONDITIONING UNIT CONTROL DIAGRAM

N.T.S.



SPLIT A/C SYSTEM (ECU-2&3) CONTROL DIAGRAM

N.T.S.



SEQUENCE OF OPERATION:

THE EXHAUST FAN SHALL RUN CONTINUOUSLY. ALARM FAN FAILURE IN THE EVENT OF A FAILURE OR SHUTDOWN DUE TO HIGH STATIC.

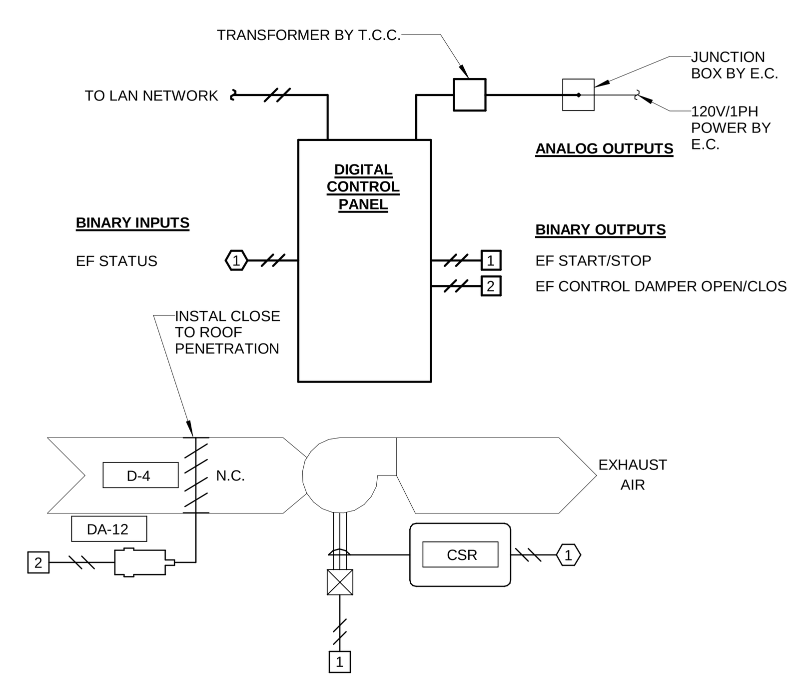
THE EXHAUST AIRFLOW SHALL BE CONTROLLED BY THE DIGITAL CONTROL PANEL MODULATING THE EXHAUST FAN VARIABLE FREQUENCY DRIVE (VFD) TO MAINTAIN A CONSTANT DUCT STATIC PRESSURE (AS SENSED BY THE DUCT STATIC PRESSURE SENSOR) TO EXHAUST ALL CONNECTED EXHAUST AIRFLOW. COOPERATE WITH BALANCE CONTRACTOR TO OBTAIN AND PROGRAM SETPOINTS.

ALARM IF STATIC PRESSURE EXCEEDS HIGH LIMIT STATIC.

UPON A READING OF A 1" INCREASE IN PRESSURE DROP ACROSS THE FILTERS RELATIVE TO THE CLEAN FILTER PRESSURE DROP, CHANGE PRE FILTERS. UPON AN INCREASE OVER 1", CHANGE PRE AND HEPA FILTERS.

EF-3
EXHAUST FAN CONTROL DIAGRAM

N.T.S.



SEQUENCE OF OPERATION:

1. EXHAUST FAN SHALL RUN CONTINUOUSLY DURING OCCUPIED PERIOD.

2. UPON A SIGNAL FROM THE DIGITAL CONTROL PANEL FOR THE FAN TO START, THE EXHAUST FAN DAMPER SHALL OPEN, AND THE FAN SHALL START.

3. UPON A SIGNAL FROM THE DIGITAL CONTROL PANEL FOR THE FAN TO STOP, THE FAN SHALL STOP, AND THE EXHAUST FAN DAMPER SHALL CLOSE.

EF-1 AND 2

EXHAUST FAN CONTROL DIAGRAM

N.T.S.

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PROJECT
RALEIGH COUNTY SHERIFF'S DEPARTMENT

OWNER
RALEIGH COUNTY COMMISSION

LOCATION
BECKLEY, WV

REVISIONS

DATE
3/01/2022

TITLE
TEMPERATURE CONTROLS- HVAC

DRAWING NUMBER
M3.0

DIFFUSER, REGISTER & GRILLE SCHEDULE

NOTES:

1. MOUNTING FRAME TYPES SHALL BE COORDINATED WITH THE ARCHITECTURAL REFLECTED CEILING PLAN.
2. FURNISH ALL DIFFUSERS, REGISTERS AND GRILLES IN STANDARD WHITE FINISH UNLESS OTHERWISE NOTED.
3. NOT ALL DIFFUSERS, REGISTERS OR GRILLES ARE NECESSARILY USED ON THIS PROJECT. SEE DRAWINGS FOR ACTUAL TYPE AND QUANTITY REQUIREMENTS.
4. THE SYMBOL ON THE DUCTWORK PLANS INDICATES THE MARK, AND THE AIR BALANCE IN CFM. THE DIFFUSER, REGISTER, OR GRILLE NECK SIZE WILL BE DETERMINED FROM THIS SCHEDULE GIVEN THE MARK (A,B,C, ETC.) AND THE CORRESPONDING CFM. MANUFACTURERS NOT LISTED MUST CONFORM TO SCHEDULED CHARACTERISTICS. IF LARGER NECK SIZES ARE REQUIRED TO OBTAIN AIR QUANTITIES WITH MAXIMUM NOISE CRITERIA (NC) SCHEDULED, INSTALLING CONTRACTOR MUST INCLUDE ALL COSTS ASSOCIATED WITH CHANGES OF THIS NATURE IN HIS BID. IN NO CASE WILL SMALLER NECK SIZES THAN SCHEDULED BE PERMITTED.
5. RETURN REGISTERS ON PLANS WITH AIR QUANTITIES NOT INDICATED SHALL BE SELECTED AND BALANCED TO RECEIVE IN EQUAL AMOUNTS THE SUM OF THE SUPPLY AIR INTRODUCED INTO THE SAME SPACE.
6. ALL DAMPERS FURNISHED IN ROUND NECK DIFFUSERS SHALL BE INSTALLED IN DUCTWORK RATHER THAN DIFFUSER NECK, AS FAR FROM DIFFUSER AS POSSIBLE AND STILL PERMIT ADJUSTMENT FROM DIFFUSER FACE.
7. ALL DIFFUSERS SHALL BE SELECTED FOR FOUR WAY THROW PATTERN UNLESS OTHERWISE INDICATED.
8. DIFFUSERS AND GRILLES SERVING ROOMS WITH SHOWERS (ROOMS 161, 162) TO BE ALUMINUM CONSTRUCTION. ALL OTHER DIFFUSERS AND GRILLES TO BE STEEL CONSTRUCTION UNLESS NOTED OTHERWISE.

NO.	MAKE	MODEL	DAMPER	MOUNTING	NOMINAL FACE SIZE	MAX NC	AIRFLOW (CFM) 50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825	850	875	900	950	1000	REMARKS
A	PRICE	SPD	NONE	LAYIN/SURFACE	24X24	20	6	6	6	8	8	8	8	10	10	10	10	10	10	10	10	12	12	12	12	14	14	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SUPPLY SQUARE PLAQUE DIFFUSER
B	PRICE	510	NONE	SURFACE	VARIES	20	8X8	8X8	8X8	8X8	8X8	8X8	8X8	8X8	8X8	10X10	10X10	10X10	10X10	10X10	10X10	10X10	12X10	12X10	12X12	12X12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SIDEWALL SUPPLY - ADJUST BLADES 45 DEGREES DOWNWARDS
C	PRICE	PDDR	NONE	LAYIN/SURFACE	24X12	20	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	22X10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PERFORATED RETURN AIR DIFFUSER
D	PRICE	PDDR	NONE	LAYIN/SURFACE	24X24	20	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	22X22	PERFORATED RETURN AIR DIFFUSER
E	PRICE	630	NONE	SURFACE	VARIES	20	8X8	8X8	8X8	8X8	8X8	8X8	8X8	8X8	8X8	10X10	10X10	10X10	10X10	10X10	10X10	12X10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SIDEWALL RETURN
F	PRICE	MSPG	NONE	SURFACE	VARIES	25	8X8	8X8	8X8	8X8	8X8	8X8	8X8	8X8	8X8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SECURITY TYPE EXHAUST
G	PRICE	MSPG	NONE	SURFACE	VARIES	25	8X8	8X8	8X8	8X8	8X8	8X8	8X8	8X8	8X8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SECURITY TYPE SUPPLY
H	PRICE	SDG	OBD	DUCT	14x4	25	14x4	14x4	14x4	14x4	14x4	14x4	14x4	14x4	14x4	14x4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	SPIRAL DUCT MOUNTED GRILLE
J	PRICE	SDS	NONE	SURFACE	48" LENGTH	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LINEAR SLOT DIFFUSER WITH (4) 1-1/2" SLOTS FIELD FABRICATE DUCTWORK PLENUM. ANGLE AIRFLOW 45 DEG DOWNWARD. SEE FLOOR PLANS FOR CONNECTION SIZES. FLANGE FRAME WITH CONCEALED MOUNTING
K	PRICE	RCDA	NONE	DUCT	24"	25	6	6	6	8	8	8	8	10	10	10	10	10	10	10	10	12	12	12	12	14	14	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ROUND FACE FULLY ADJUSTABLE DIFFUSER
L	PRICE	510	NONE	SURFACE	VARIES	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NECK SIZE TO MATCH ASSOCIATED DUCTWORK SIZES
M	PRICE	RCDA	NONE	DUCT	24"	25	6	6	6	8	8	8	8	10	10	10	10	10	10	10	10	12	12	12	12	14	14	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ROUND FACE FULLY ADJUSTABLE DIFFUSER
N	PRICE	SDS	NONE	SURFACE	48" LENGTH	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	RETURN AIR LINEAR SLOT DIFFUSER WITH (4) 1-1/2" SLOTS, DO NOT INSTALL WITH PLENUM. ANGLE AIRFLOW 45 DEG UPWARD. FLANGE FRAME WITH CONCEALED MOUNTING

FAN SCHEDULE

NOTES:

1. SEE SPECIFICATIONS FOR REQUIRED ACCESSORIES.
2. PROVIDE ALL FANS WITH INTEGRAL DISCONNECTS.

NO.	MAKE	MODEL	SERVICE	DESCRIPTION	DRIVE TYPE	CFM	ESP (IN. W.C.)	MAX BHP	MHP	FAN RPM	VOLTS/ PHASE	MAX FAN DISCHARGE SOUND LEVELS								REMARKS
												63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	8 KHz	
EF-1	GREENHECK	G-133-VG	GENERAL EXHAUST	CENTRIFUGAL	DIRECT	1425	1	0.38	0.75	1509	115/1	77	77	80	72	67	65	60	54	PROVIDE WITH LOCAL SPEED DIAL ON FAN ASSEMBLY
EF-2	GREENHECK	G-103HP-VG	GENERAL EXHAUST	CENTRIFUGAL	DIRECT	600	1	0.25	0.5	2014	115/1	79	82	74	71	66	61	60	57	PROVIDE WITH LOCAL SPEED DIAL ON FAN ASSEMBLY
EF-3	GREENHECK	USF-16	EVIDENCE EXHAUST	UTILITY SET	DIRECT	1750	4	1.8	3	2882	208/3	101	95	93	92	85	81	77	74	

DUCT MATERIAL SCHEDULE

TYPE NO.	SMACNA PRESSURE CLASSIFICATION	DUCT MATERIAL	INSULATION
1	2"	GALVANIZED STEEL	INTERNAL 1" DUCT LINING
2	2"	GALVANIZED STEEL	EXTERNAL, FIELD APPLIED (WRAP OR RIGID - SEE SPECIFICATIONS)
3	2"	GALVANIZED STEEL	NONE
4	26 GAUGE SNAPLOCK	GALV. STEEL, SINGLE WALL, FACTORY FAB. SPIRAL	EXTERNAL, FIELD APPLIED (WRAP OR RIGID - SEE SPECIFICATIONS)
5	2"	ALUMINUM	NONE
6	4"	GALVANIZED STEEL	NONE
7	4"	GALVANIZED STEEL	INTERNAL 1" LINING
8	6"	316 STAINLESS STEEL	NONE
9	4"	GALVANIZED STEEL	EXTERNAL, FIELD APPLIED (WRAP OR RIGID - SEE SPECIFICATIONS)
10	10"	GALVANIZED STEEL, DOUBLE WALL, PERFORATED LINER FACTORY FAB. SPIRAL	FACTORY APPLIED BETWEEN INNER AND OUTER WALLS

NOTES:

A. SIZES OF INTERNALLY LINED DUCTWORK INDICATED ON THE PLANS ARE ACTUAL SHEET METAL DIMENSIONS (i.e. THE THICKNESS OF THE INTERNAL LINING HAS BEEN CONSIDERED).
B. SIZES OF DOUBLE-WALLED DUCTWORK INDICATED ON THE PLANS ARE INTERNAL SHEET METAL DIMENSIONS.
C. PRESSURE CLASSIFICATIONS SCHEDULED ARE IN ACCORDANCE WITH THE LATEST EDITION OF THE SMACNA "HVAC DUCT CONSTRUCTION STANDARDS". REFER ALSO TO SPECIFICATIONS.
D. ALL DUCTWORK RUN OUTS TO TERMINAL UNITS TO BE THE INLET SIZE OF THE TERMINAL UNIT, UNLESS NOTED OTHERWISE.
E. THE FIRST FIGURE OF DUCT SIZE INDICATES THE DIMENSION OF THE FACE SHOWN OR INDICATED.
F. REFER TO THE ARCHITECTURAL REFLECTED CEILING PLANS FOR EXACT LOCATIONS OF CEILING OUTLETS AND INLETS.
G. ALL SUPPLY AIR DUCTWORK TO BE TYPE 9 UNLESS OTHERWISE NOTED.
H. ALL DUCTWORK ASSOCIATED WITH VRV UNITS TO BE TYPE 2.
I. ALL GENERAL EXHAUST AIR DUCTWORK TO BE TYPE 3 UNLESS OTHERWISE NOTED.
J. UNLESS OTHERWISE NOTED, ALL FIRE DAMPERS SHOWN IN RECTANGULAR SUPPLY, RETURN AND EXHAUST DUCTWORK SHALL CARRY 1-1/2 HOUR RATING WITH FRAME STYLE "B".
K. UNLESS OTHERWISE NOTED, ALL FIRE DAMPERS SHOWN IN ROUND OR FLAT OVAL SUPPLY DUCTWORK SHALL CARRY 1-1/2 HOUR RATING WITH FRAME STYLE "C".
L. FOR LOW PRESSURE DUCTWORK (SMACNA CLASSIFICATION 2" W.G. AND LESS) - MINIMUM SIZE OF THE ACCESS PANEL IN THE DUCTWORK FOR FUSIBLE LINK REPAIR SHALL BE 2" LESS THAN WIDTH OF THE DUCT BY 12" IN LENGTH, UP TO A MAXIMUM OF 18" WIDE, UNLESS OTHERWISE NOTED ON DRAWINGS. ACCESS DOORS SHALL BE HINGED IN MECHANICAL ROOMS WHERE DOOR SWING CLEARANCE PERMITS, OTHERWISE CAM LOCK TYPE.
M. FOR MEDIUM AND HIGH PRESSURE DUCTWORK (SMACNA CLASSIFICATION 3" W.G. AND GREATER) - MINIMUM SIZE OF THE ACCESS PANEL IN THE FUSIBLE LINK REPAIR SHALL BE 8" WIDE BY 12" LONG FOR ROUND DUCTS 5" TO 12" IN DIAMETER AND FLAT OVAL DUCTS 8" TO 16" WIDE; PANEL TO BE 12" WIDE BY 12" LONG FOR ROUND DUCTS 13" TO 18" IN DIAMETER AND FLAT OVAL DUCTS 17" TO 24" WIDE; PANEL TO BE 14" WIDE BY 12" LONG FOR ROUND DUCTS 19" IN DIAMETER AND HIGHER AND FLAT OVAL DUCTS 25" AND HIGHER. ACCESS PANELS IN MEDIUM AND HIGH PRESSURE RECTANGULAR DUCTWORK SHALL BE THE SAME SIZES AS REQUIRED FOR LOW PRESSURE DUCTWORK.
N. ALL RETURN, EXHAUST, AND COMBUSTION AIR DUCT PRESSURE CLASSES TO BE NEGATIVE.
O. ALL RETURN AIR BOOT AND TRANSFER AIR DUCTWORK TO BE TYPE 1.
P. ALL DUCTWORK ASSOCIATED WITH ROOM 171 UPSTREAM OF HEPA FILTER BANK TO BE CONSIDERED HAZARDOUS EXHAUST. INDOOR DUCTWORK IS TO BE TYPE 6. ALL OUTDOOR DUCTWORK ASSOCIATED WITH EF-3 TO BE TYPE 8. SEE SPECIFICATIONS FOR LABELING REQUIREMENTS. MAINTAIN 1" CLEARANCE TO COMBUSTIBLES.
Q. EXHAUST AIR DUCTWORK SERVING ROOMS 161 AND 162 TO BE TYPE 5 BACK TO EXHAUST FAN CONNECTION.
R. ALL EXPOSED ROUND DUCTWORK IN ROOM 149 TO BE TYPE 10.

ELECTRIC CABINET UNIT HEATER SCHEDULE

NOTES:

1. SEE SPECIFICATIONS AND DETAILS FOR REQUIRED ACCESSORIES.
2. CENTER UNITS UNDER WINDOWS OR ON WALLS, UNLESS OTHERWISE INDICATED.

NO.	MAKE	MODEL	DESCRIPTION	CAPACITY	VOLTS/PHASE	REMARKS
CUH-1	QMARK	CU935	RECESSED WALL MOUNTED	6 KW	208/3	PROVIDE WITH INTEGRAL DISCONNECT

ELECTRIC UNIT HEATER SCHEDULE

NOTES:

1. PROVIDE UNIT HEATERS WITH INTEGRAL THERMOSTATS.
2. SEE SPECIFICATIONS FOR ADDITIONAL REQUIRED ACCESSORIES.

SBM_U_NO.	MAKE	MODEL	TYPE	CAPACITY KW	CAPACITY STAGES	DELTA T	CFM	MHP	VOLTS/PHASE	REMARKS
UH-1	QMARK	MUH03-81	VERTICAL	3.0	2	27	350	1/100	208/1	
UH-2	QMARK	MUH03-81	VERTICAL	3.0	2	27	350	1/100	208/1	

ELECTRIC WALL HEATER SCHEDULE

NOTES:

1. PROVIDE ALL ELECTRIC WALL HEATERS WITH INTEGRAL TAMPERPROOF THERMOSTATS.

NO.	MAKE	MODEL	DESCRIPTION	CAPACITY	CAPACITY STAGE	W"xH"xD"	VOLTS / PHASE	REMARKS
EWH-1	MARLEY	AWH4408F	ELECTRIC WALL HEATER	4 KW	1	19.2x15.75x3.9	208/1	
EWH-2	MARLEY	AWH4408F	ELECTRIC WALL HEATER	4 KW	1	19.2x15.75x3.9	208/1	
EWH-3	MARLEY	AWH4408F	ELECTRIC WALL HEATER	4 KW	1	19.2x15.75x3.9	208/1	
EWH-4	MARLEY	AWH4408F	ELECTRIC WALL HEATER	4 KW	1	19.2x15.75x3.9	208/1	
EWH-5	MARLEY	AWH4408F	ELECTRIC WALL HEATER	4 KW	1	19.2x15.75x3.9	208/1	
EWH-6	MARLEY	AWH4408F	ELECTRIC WALL HEATER	4 KW	1	19.2x15.75x3.9	208/1	
EWH-7	MARLEY	AWH4408F	ELECTRIC WALL HEATER	4 KW	1	19.2x15.75x3.9	208/1	
EWH-8	MARLEY	AWH4408F	ELECTRIC WALL HEATER	4 KW	1	19.2x15.75x3.9	208/1	

ENVIRONMENTAL CONDITIONING UNIT SCHEDULE

NOTES:

1. SEE SPECIFICATIONS FOR REQUIRED ACCESSORIES.
2. TEMPERATURES INDICATED ARE FOR RATING PURPOSES ONLY, AND MAY NOT REPRESENT ACTUAL OPERATING CONDITIONS.
3. PROVIDE WITH INTEGRAL CONDENSATE PUMPS.
4. REFRIGERANT PIPING SIZES AND ROUTES TO BE REVIEWED WITH MANUFACTURER PRIOR TO INSTALLATION.
5. PROVIDE WITH LOW AMBIENT KITS/WIND BAFFLES IF REQUIRED TO MEET PERFORMANCE DATA BELOW.

NO.	MAKE	MODEL	TYPE	VOLTS / PHASE	FAN DATA	COOLING COILS	HEATING CAPACITY	AIR-COOLED CONDENSER				REMARKS
					CFM	TOT MBH	MBH	MODEL	TYPE	MAX AMBIENT DEG. F	MIN AMBIENT DEG F.	
ECU-1	DAIKIN	FTX24NMVJU	WALL MT	208/1	745	24	24	RX24NMVJU	PROPELLER	115	-4	PROVIDE WITH CONDENSATE PUMP AS REQUIRED

ELECTRIC BASEBOARD HEAT SCHEDULE

NOTES:

1. SEE SPECIFICATIONS AND DETAILS FOR REQUIRED ACCESSORIES.
2. CENTER UNITS UNDER WINDOWS OR ON WALLS, UNLESS OTHERWISE INDICATED.
3. PROVIDE WITH PEDESTAL MOUNTING. BOTH SIDES OF BASEBOARD TO HAVE PANELS.
4. COORDINATE FINAL COLORS/FINISHES WITH ARCHITECT.
5. PROVIDE TRIM COVERS FOR CONTINUOUS APPEARANCE BETWEEN UNITS.
6. PROVIDE PHYSICAL SAMPLES OF STANDARD AND DESIGNER COLORS TO ARCHITECT.

NO.	MAKE	MODEL	DESCRIPTION	CAPACITY (BTU)	LENGTH	VOLTS/PHASE	REMARKS
BB-1	RUNTAL	EBP-208D	PEDESTAL MOUNTED	1500	3'	208/1	
BB-2	RUNTAL	EBP-208D	PEDESTAL MOUNTED	2500	5'	208/1	
BB-3	RUNTAL	EBP-208D	PEDESTAL MOUNTED	3500	7'	208/1	
BB-4	RUNTAL	EBP-208D	PEDESTAL MOUNTED	4000	8'	208/1	

FILTER BANK SCHEDULE

NOTES:

1. FILTER SHALL BE SIDE LOADED WITH BAG-IN, BAG-OUT OPERATION, PROVIDE WITH PHOTOHELIC GAGES WITH THE PRE AND HEPA FILTER SECTIONS.
2. FILTER HOUSE SHALL BE FURNISHED WITH INLET AND OUTLET DUCT FLANGES FOR DUCTWORK CONNECTION.
3. SEE SPECIFICATIONS FOR ADDITIONAL REQUIRMENTS.

NO.	SERVICE	INITIAL BANK APD	FINAL BANK APD	FILTER FRAME AND/OR HOUSING				FILTER MEDIA					REMARKS
				MANUFACTURER	WIDTH	HEIGHT	MINIMUM DEPTH	MANUFACTURER	MODEL	FILTER EFFICIENCY	INDIVIDUAL FILTER SIZE (WxHxD)	TOTAL QUANTITY	
F-EF-3A	EF-3 PREFILTER	0.2"	1"	P&G	27"	29-3/4"	36-1/2"	FLANDERS	--	MERV 8	24"x24"x4"	1	
F-EF-3B	EF-3 HEPA FILTER	1.25"	2"					FLANDERS	ASTROCEL	95% HEPA	24"x24"x11-1/2"	1	

VARIABLE FREQUENCY DRIVE SCHEDULE

NOTES:

1. ALL VARIABLE FREQUENCY DRIVES FURNISHED FOR THIS PROJECT TO BE BY THE SAME MANUFACTURER.
2. FURNISH WITH SEPARATE CONTACTOR, OVERLOAD PROTECTION, AND BRANCH CIRCUIT PROTECTION FOR ALL MULTIPLE MOTOR INSTALLATIONS.
3. SEE TEMPERATURE CONTROL SEQUENCE OF OPERATION FOR COORDINATION WITH TEMPERATURE CONTROLS.
4. SEE SPECIFICATIONS FOR REQUIRED ACCESSORIES.

NO.	MAKE	MODEL	SERVICE	TYPE	OUTPUT HP SERVED	DRIVE HP	DRIVE V/PH	REMARKS
VFD-EF-3	ABB	ACH550	EF-3	HVAC	3	3	208/3	

ENVIRONMENTAL CONDITIONING UNIT SCHEDULE (LIEBERT)

NOTES:

1. SEE SPECIFICATIONS FOR REQUIRED ACCESSORIES.
2. COOLING CAPACITY SCHEDULED INCLUDES EFFECT OF FAN MOTOR HEAT.
3. SEE OTHER SCHEDULES FOR COMPONENTS NOT LISTED.
4. TEMPERATURES INDICATED ARE FOR RATING PURPOSES ONLY, AND MAY NOT REPRESENT ACTUAL OPERATING CONDITIONS.
5. PROVIDE WITH SCROLL COMPRESSORS WITH HOT GAS BYPASS.

NO.	MAKE	MODEL	TYPE	VOLTS / PHASE	FAN DATA				COOLING COILS				HEATING COIL (ELECTRIC)		AIR-COOLED CONDENSER	REMARKS
					CFM	ESP IN.	QTY	MPH	EDB DEG. F	EWB DEG. F	SENS MBH	TOT MBH	KW	VOLTS/PHASE	MODEL	
ECU-2	LIEBERT	DME037E-PHN	WALL MT	208-230/1	1320	0.3	1	0.5	72	60	28	32.7	5.5	208/1	PFH037A-YLN	SERVER ROOM UNIT. PROVIDE WITH CONDENSATE PUMP
ECU-3	LIEBERT	DME037E-PHN	WALL MT	208-230/1	1320	0.3	1	0.5	72	60	28	32.7	5.5	208/1	PFH037A-YLN	SERVER ROOM UNIT. PROVIDE WITH CONDENSATE PUMP

SOUND ATTENUATOR SCHEDULE

NOTES:

1. MAXIMUM AIR PRESSURE DROP IS AT ACTUAL FACE VELOCITY.
2. SOUND RATING PERFORMANCE IS AT SOUND VELOCITY.
3. DYNAMIC INSERTION LOSS IS AT INDICATED OCTAVE BAND AND CENTER FREQUENCY (HZ).

SOUND ATTENUATOR SCHEDULE

NO.	MAKE	MODEL	SERVES	ATTENUATOR OVERALL SIZE H"xW"xL"	CFM PER ATTEN.	ACTUAL VELOCITY (FPM)	MAX APD IN. WG	DYNAMIC INSERTION LOSS (db)								REMARKS
								63	125	250	500	1000	2000	4000	8000	
SA-EF-3A	PRICE	RM120/1D	EF-3 INLET	12 x 24 x 120	1750	875	0.15	16	25	40	55	55	55	46	31	STRAIGHT ATTENUATOR
SA-EF-3B	PRICE	RH60/4C	EF-3 DISCHARGE	10.15 x 17.6 x 60	1750	1411	0.11	6	9	15	29	27	20	15	11	STRAIGHT ATTENUATOR. RATED FOR OUTDOORS.

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PROJECT

RALEIGH COUNTY SHERIFF'S DEPARTMENT

OWNER

RALEIGH COUNTY COMMISSION

LOCATION

BECKLEY, WV

REVISIONS

DATE

3/01/2022

TITLE

SCHEDULES- HVAC

DRAWING NUMBER

M4.0

MAKE UP AIR UNIT SCHEDULE

NOTES:

1. FOR TYPE FAN, CENT=CENTRIFUGAL, VA=VANEAXIAL, PROP=PROPELLER, FC=FORWARD CURVED, BI=BACKWARDLY INCLINED, AF=AIRFOIL.
2. ROOFTOP UNIT EXTERNAL STATIC PRESSURE (ESP) INCLUDES ALL DUCTWORK AND ACCESSORY LOSSES UPSTREAM AND DOWNSTREAM OF DUCTWORK CONNECTIONS TO ROOFTOP UNIT. ALL OTHER STATIC PRESSURE IS INTERNAL. ENTRANCE AND EXIT LOSSES ARE CONSIDERED INTERNAL.
3. SEE SPECIFICATIONS FOR REQUIRED ACCESSORIES.
4. COOLING CAPACITY SCHEDULES INCLUDES EFFECT OF FAN MOTOR HEAT.
5. PROVIDE WITH INTEGRAL UNIT DISCONNECT.

NO.	MODEL	TYPE	MAKE	VOLTS/ PHASE	MAX OA CFM	SUPPLY FAN					COOLING SYSTEM							HEAT EXCHANGER						RETURN, OUTSIDE AIR, SUPPLY AIR PREFILTER		REMARKS
						CFM	ESP	TYPE	MAX. BHP	MHP	EDB DEG. F	EWB DEG. F	LDB DEG. F	LWB DEG. F	TOT MBH	AMB DEG. F	MIN. STEPS UNLOADING	FUEL TYPE	TYPE	EAT DEG. F	MBH INPUT	LAT DEG. F	MBH OUTPUT	MERV RATING	LOADED APD	
MAU-1	DPS015	CONSTANT VOLUME	DAIKIN	208/3	5250	2700	1.5	AF	1	2	92	73	55	54.8	164	0	INVERTER	N. GAS	MODULATING	0	204	70	163	8	0.5	
MAU-2	DPS012	CONSTANT VOLUME	DAIKIN	208/3	4200	2300	1.5	AF	1	2	92	73	55	54.8	139	0	INVERTER	N. GAS	MODULATING	0	173	70	139	8	0.5	

VRV INDOOR UNIT SCHEDULE

NOTES:

1. FAN COIL UNIT EXTERNAL STATIC PRESSURE (ESP) INCLUDES ALL DUCTWORK AND ACCESSORY LOSSES UPSTREAM AND DOWNSTREAM OF DUCTWORK CONNECTIONS TO FCU (WHERE APPLICABLE). ALL OTHER STATIC PRESSURE IS INTERNAL. SCHEDULES PRESSURES REFLECTED RATED FAN PERFORMANCE AT HIGH FAN SPEED.IS INTERNAL.
2. SEE SPECIFICATIONS FOR REQUIRED FEATURE AND ACCESSORIES.
3. CAPACITY FOR SELECTION PURPOSES BASED ON HGIH FAN SPEED UNLESS OTHERWISE INDICATED.
4. ALL INDOOR UNITS TO BE PROVIDED WITH CONDENSATE PUMPS UNLESS NOTED OTHERWISE.
5. ALL WALL MOUNTED UNITS MOUNTED ABOVE CABINETS/OBSTRUCTIONS TO BE PROGRAMMED TO BLOW HORIZONTALLY TO AVOID AIRFLOW OBSTRUCTION.
6. MOUNT WALL MOUNTED UNITS AS HIGH AS POSSIBLE. MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES.
7. VRV UNITS LOCATED IN METAL CEILING TO BE A CUSTOM COLOR. COORDINATE PAINTING REQUIREMENTS FOR ALL INDOOR UNITS WITH ARCHITECT. D...

NO.	MAKE	MODEL	CFM	TYPE	ASSOCIATED OUTDOOR UNIT	COOLING PERFORMANCE	ELECTRICAL	HEATING PERFORMANCE TOTAL (MBH)
						TOTAL (MBH)	VOLTAGE / PHASE	
ID-1	DAIKIN	FXZQ12TAVJU	353	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-1	10	208-230/1	14
ID-2	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-1	5	208-230/1	7
ID-3	DAIKIN	FXZQ07TAVJU	307	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-1	6	208-230/1	9
ID-4	DAIKIN	FXZQ07TAVJU	307	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-1	6	208-230/1	9
ID-5	DAIKIN	FXZQ05TAVJU	300	CONCEALED DUCTED	OD-1	5	208-230/1	7
ID-6	DAIKIN	FXSQ07TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-1	6	208-230/1	9
ID-7	DAIKIN	FXSQ12TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-1	10	208-230/1	14
ID-8	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-1	5	208-230/1	7
ID-9	DAIKIN	FXZQ09TAVJU	317	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-1	8	208-230/1	11
ID-10	DAIKIN	FXSQ07TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-1	6	208-230/1	9
ID-11	DAIKIN	FXZQ07TAVJU	307	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-1	6	208-230/1	9
ID-12	DAIKIN	FXZQ12TAVJU	353	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-1	10	208-230/1	14
ID-13	DAIKIN	FXSQ05TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-1	5	208-230/1	7
ID-14	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-2	5	208-230/1	7
ID-15	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-2	5	208-230/1	7
ID-16	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-2	5	208-230/1	7
ID-17	DAIKIN	FXMQ72MVJU	2048	CONCEALED DUCTED	OD-2	61	208-230/1	84
ID-18	DAIKIN	FXSQ54TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-2	47	208-230/1	7
ID-19	DAIKIN	FXSQ05TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-2	5	208-230/1	7
ID-20	DAIKIN	FXSQ07TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-2	6	208-230/1	9
ID-21	DAIKIN	FXSQ18TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-2	15	208-230/1	21
ID-22	DAIKIN	FXZQ12TAVJU	353	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-2	10	208-230/1	14
ID-23	DAIKIN	FXSQ30TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-3	26	208-230/1	35
ID-24	DAIKIN	FXSQ24TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-3	21	208-230/1	28
ID-25	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-2	5	208-230/1	7
ID-26	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-2	5	208-230/1	7
ID-27	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-2	5	208-230/1	7
ID-28	DAIKIN	FXSQ05TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-3	5	208-230/1	7
ID-29	DAIKIN	FXZQ12TAVJU	353	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-3	10	208-230/1	14
ID-30	DAIKIN	FXZQ09TAVJU	317	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	8	208-230/1	11
ID-31	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	5	208-230/1	7
ID-32	DAIKIN	FXZQ12TAVJU	353	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	10	208-230/1	14
ID-33	DAIKIN	FXZQ09TAVJU	317	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	8	208-230/1	11
ID-34	DAIKIN	FXSQ15TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-3	13	208-230/1	18
ID-35	DAIKIN	FXSQ09TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-3	8	208-230/1	11
ID-36	DAIKIN	FXZQ09TAVJU	317	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	8	208-230/1	11
ID-37	DAIKIN	FXSQ36TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-4	31	208-230/1	41
ID-38	DAIKIN	FXMQ72MVJU	2048	CONCEALED DUCTED	OD-4	61	208-230/1	84
ID-39	DAIKIN	FXSQ54TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-4	47	208-230/1	62
ID-40	DAIKIN	FXZQ15TAVJU	405	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	13	208-230/1	18
ID-41	DAIKIN	FXZQ05TAVJU	300	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	5	208-230/1	7
ID-42	DAIKIN	FXZQ09TAVJU	317	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	8	208-230/1	11
ID-43	DAIKIN	FXMQ72MVJU	2048	CONCEALED DUCTED	OD-2	61	208-230/1	84
ID-44	DAIKIN	FXSQ54TAVJU	2048	MSP CONCEALED DUCTED UNIT	OD-4	35	208-230/1	64
ID-45	DAIKIN	FXZQ12TAVJU	353	4-WAY DISCHARGE CEILING CASSETTE (2'x2')	OD-4	10	208-230/1	14

VRV AIR COOLED CONDENSING UNIT SCHEDULE

NOTES:

1. REFRIGERANT SHALL BE R410A. SEE SPECIFICATIONS FOR REQUIRED ACCESSORIES.

NO.	MAKE	MODEL	COMP. TYPE	TOTAL COOLING (MBH)	VOLTS / PHASE/ MCA	TOTAL HEATING (MBH)
OD-1	DAIKIN	REYQ96XAYDA	AIR COOLED HEAT RECOVERY	86	460 / 3 / 21.1	86
OD-2	DAIK	REYQ216XAYDA	AIR COOLED HEAT RECOVERY	216	460 / 3 / 42.2	182
OD-3	DAIK	REYQ96XAYDA	AIR COOLED HEAT RECOVERY	78	460 / 3 / 21.1	86
OD-4	DAIK	REYQ240XAYDA	AIR COOLED HEAT RECOVERY	239	460 / 3 / 42.2	187

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Columbus, OH 43215
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1540 Corporate Woods Parkway
Uniontown, OH 44685
Phone: (330) 896-4664

PROJECT

RALEIGH COUNTY SHERIFF'S DEPARTMENT

OWNER

RALEIGH COUNTY COMMISSION

LOCATION

BECKLEY, WV

REVISIONS

DATE

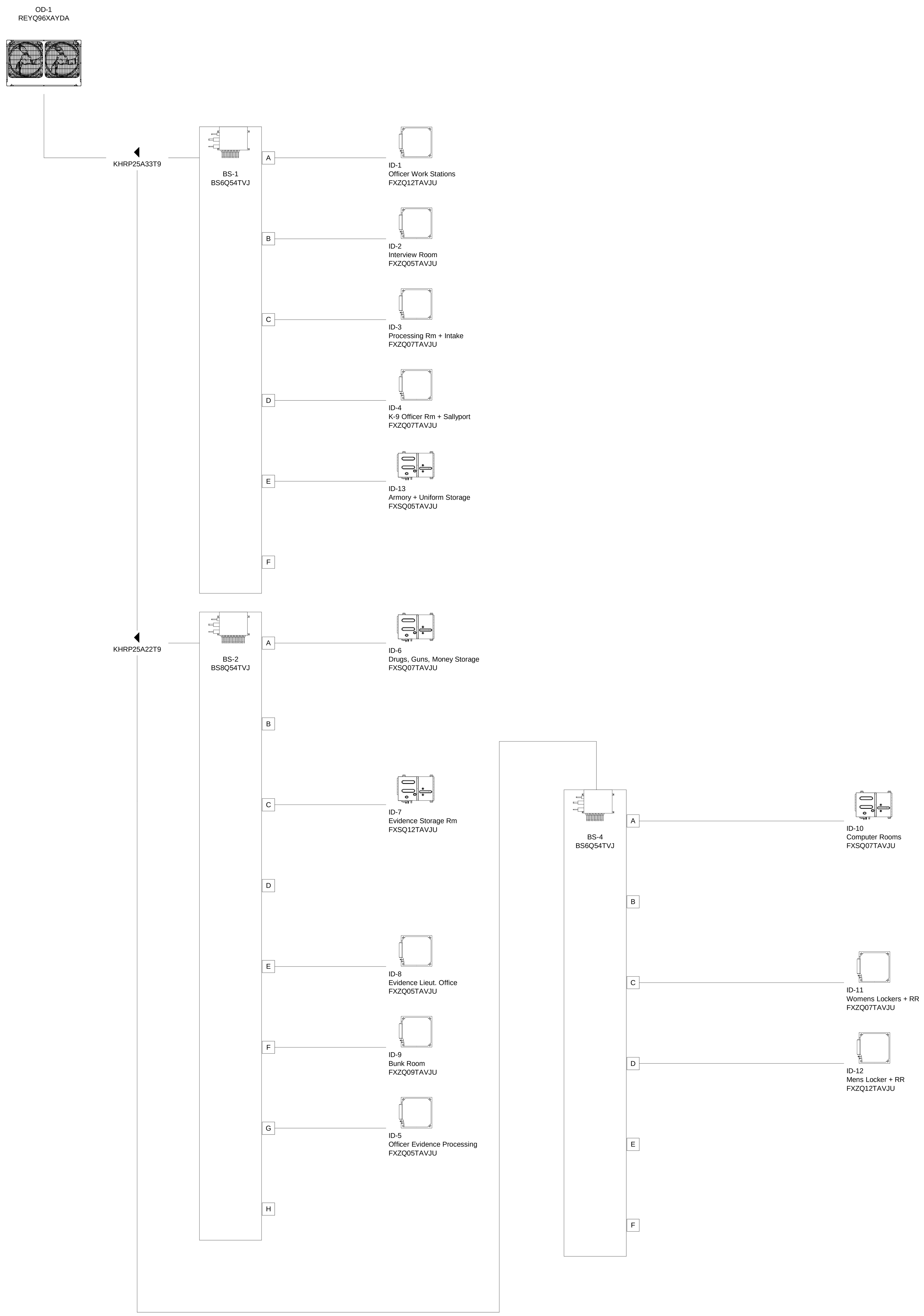
3/01/2022

TITLE

SCHEDULES - HVAC

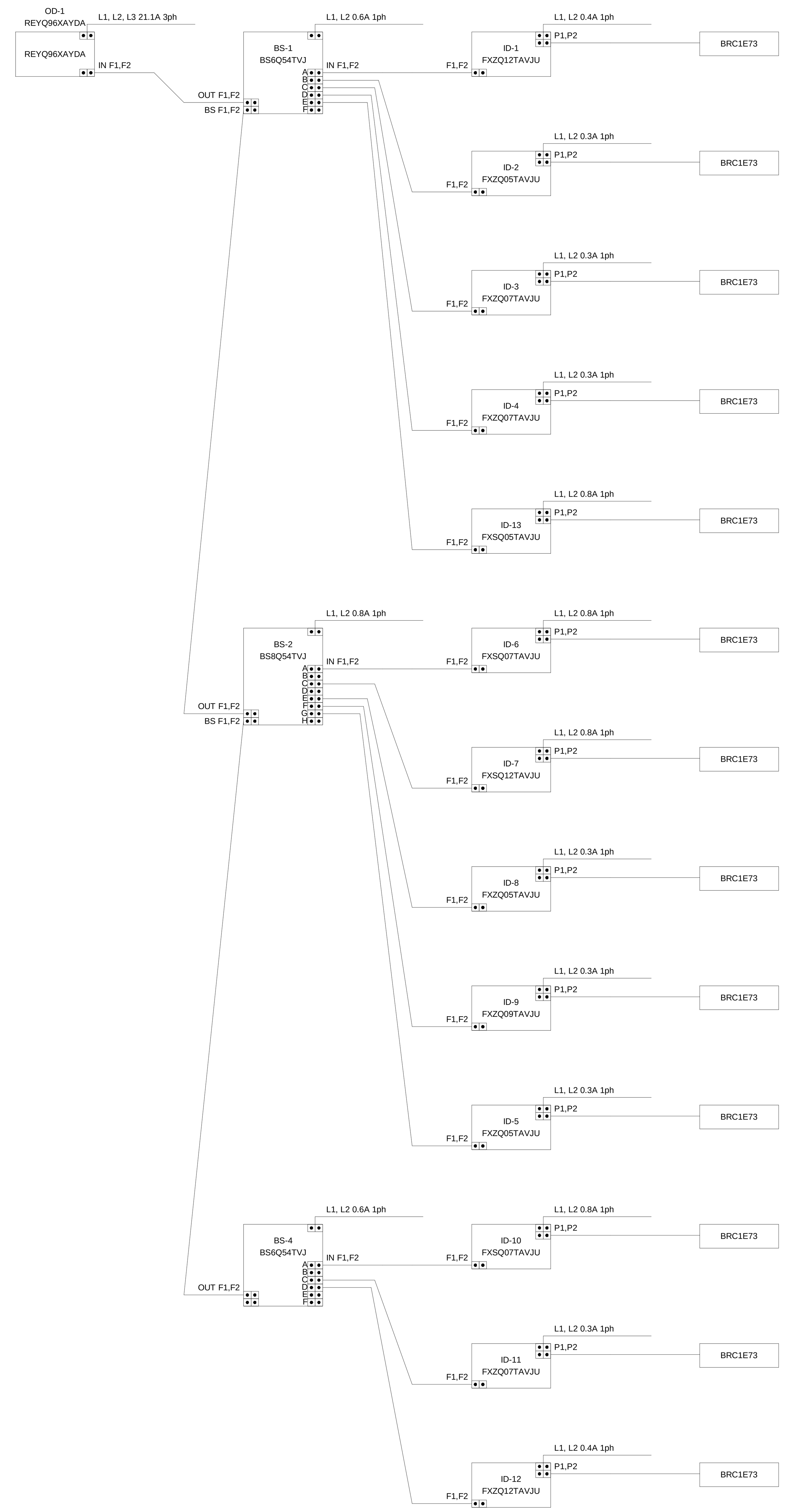
DRAWING NUMBER

M4.1



OD-1 PIPING

1/8" = 1'-0"



OD-1 WIRING

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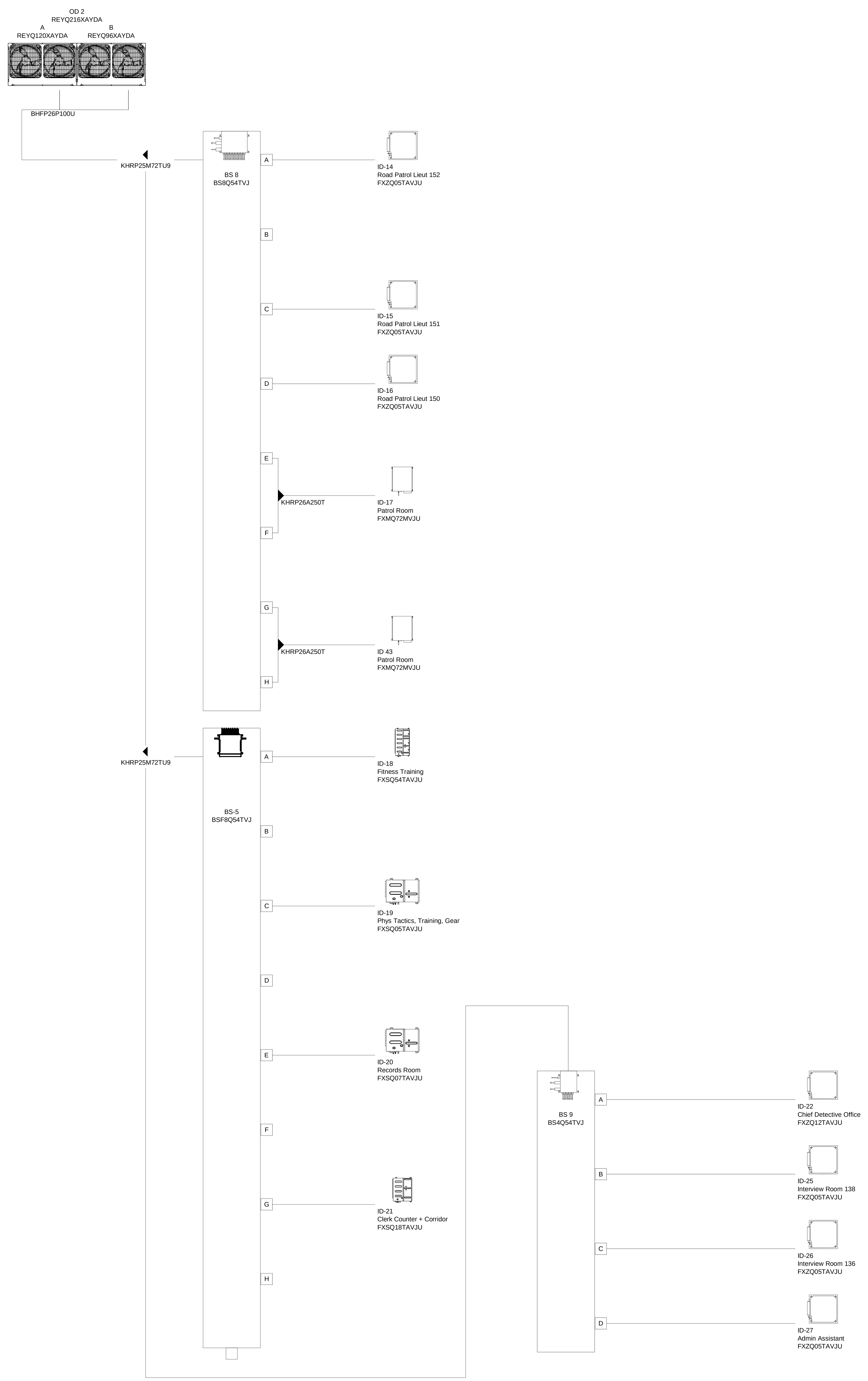
OD-1 PIPING AND WIRING

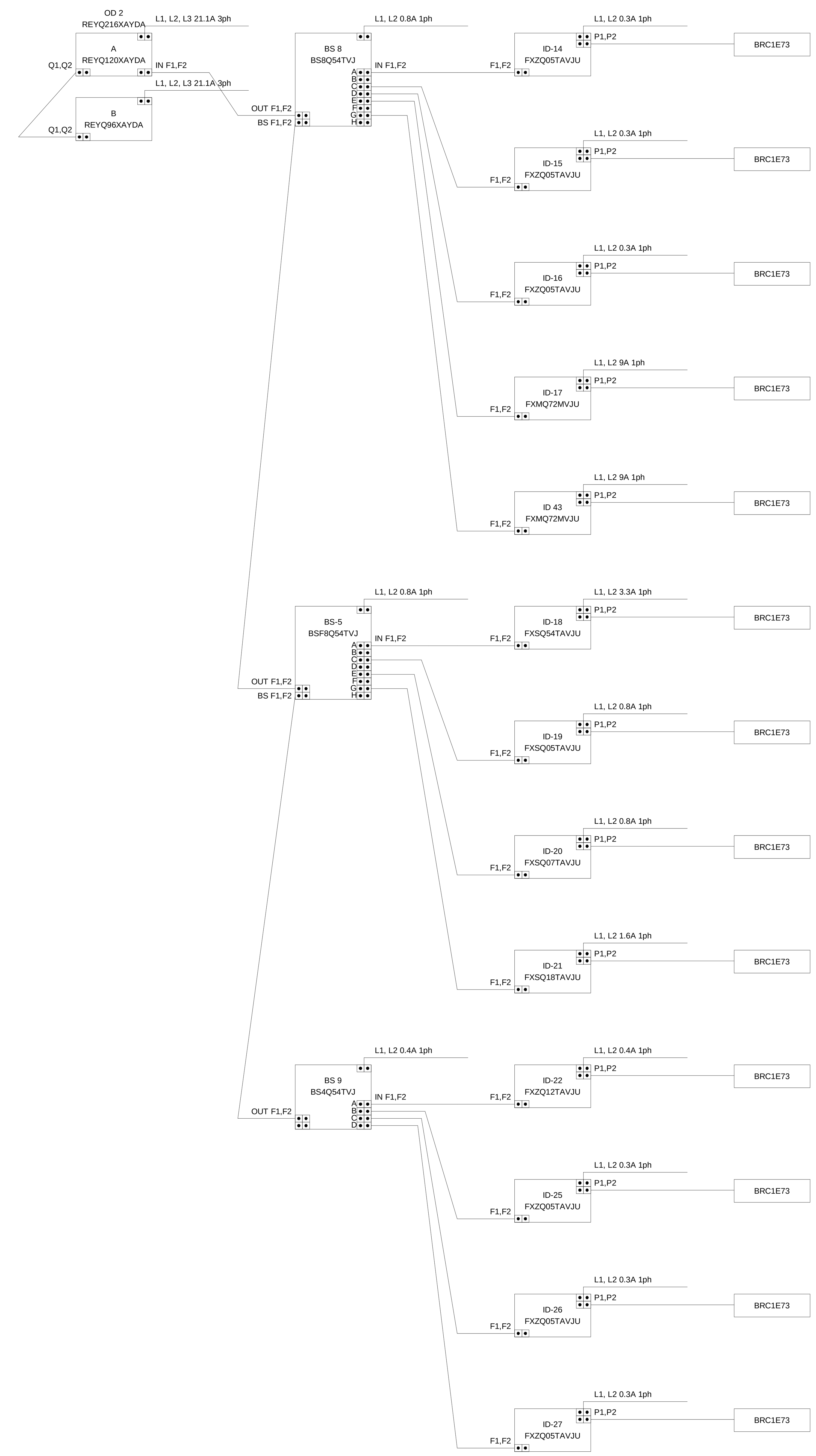
DRAWING NUMBER

M5.0



OD-2 PIPING

1/8" = 1'-0"



OD-2 WIRING

1/8" = 1'-0"

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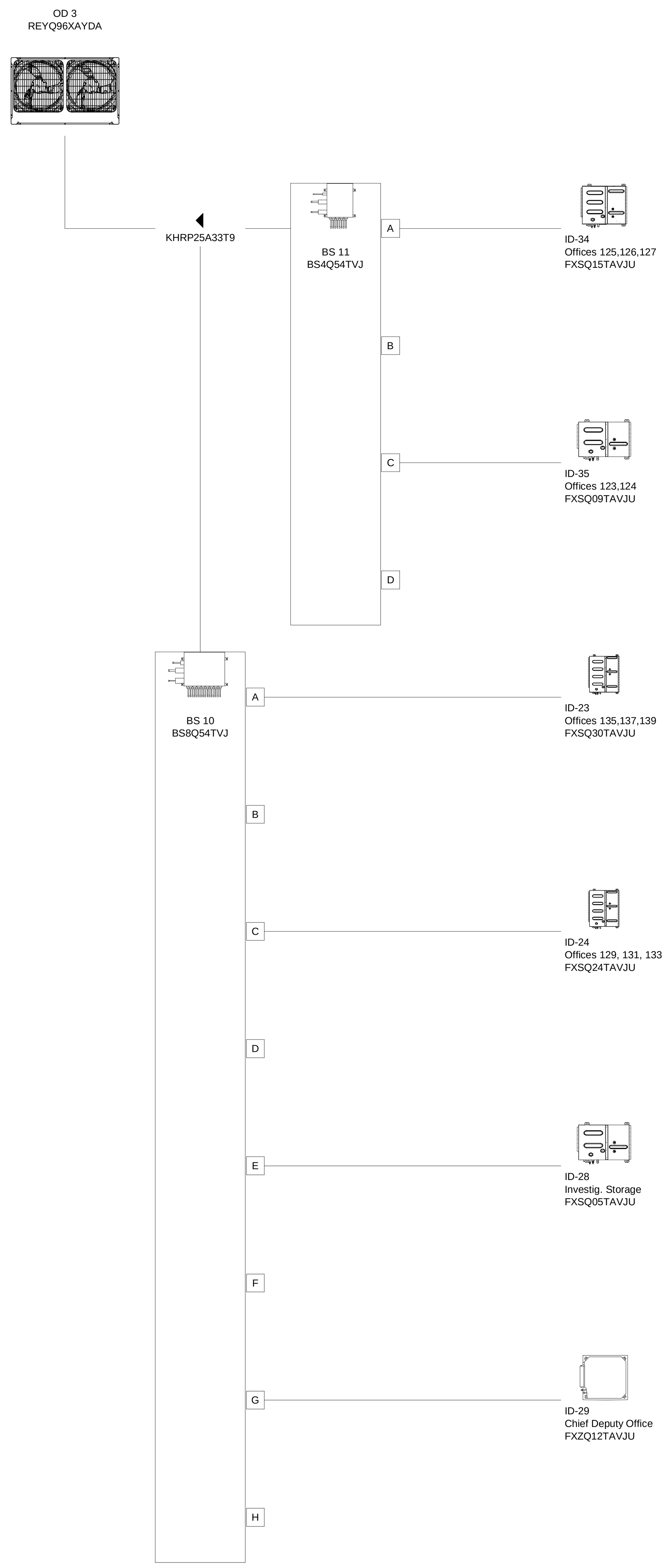
OD-2 PIPING AND WIRING

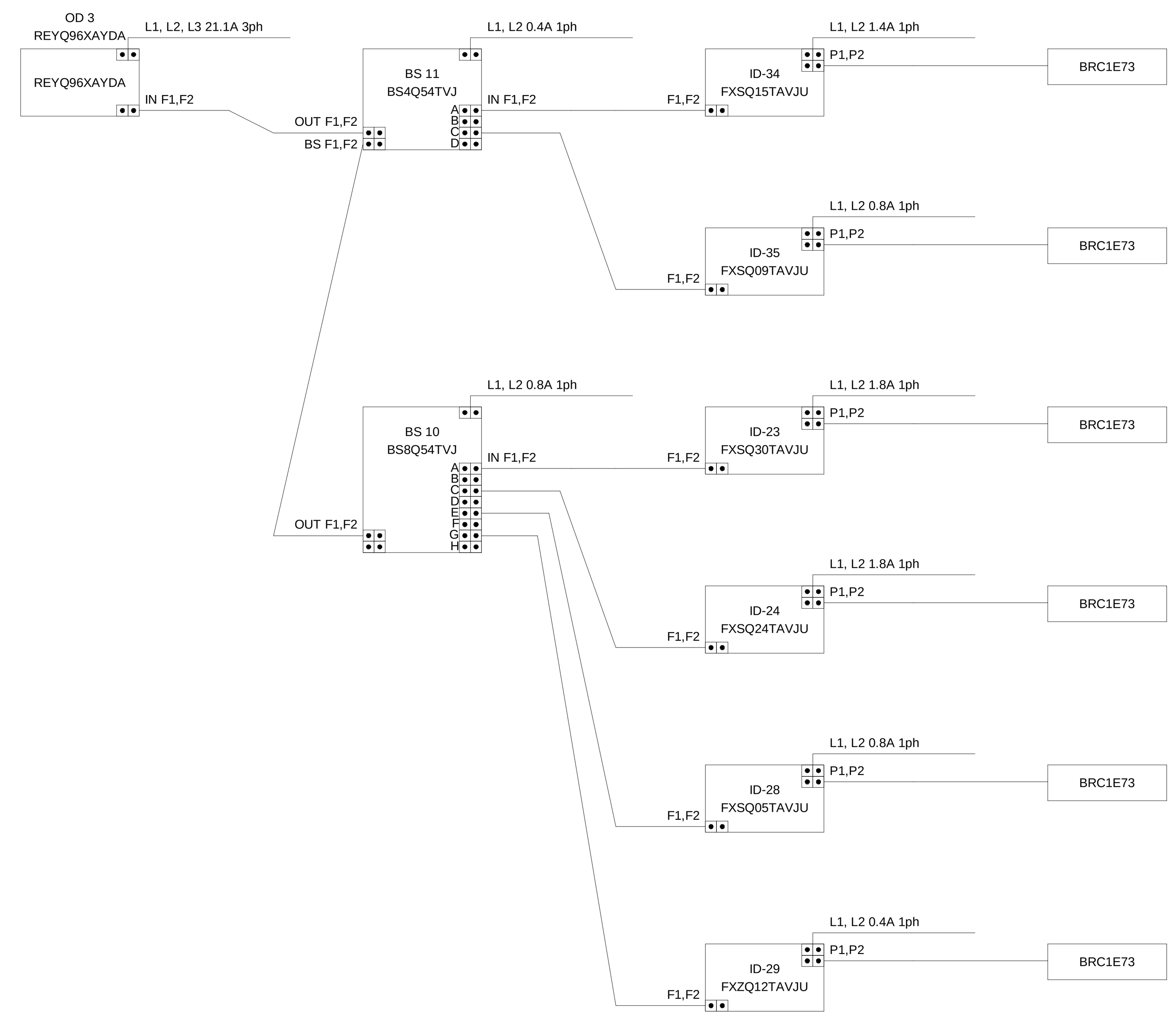
DRAWING NUMBER

M5.1



OD-3 PIPING

1/8" = 1'-0"



OD-3 WIRING

1/8" = 1'-0"

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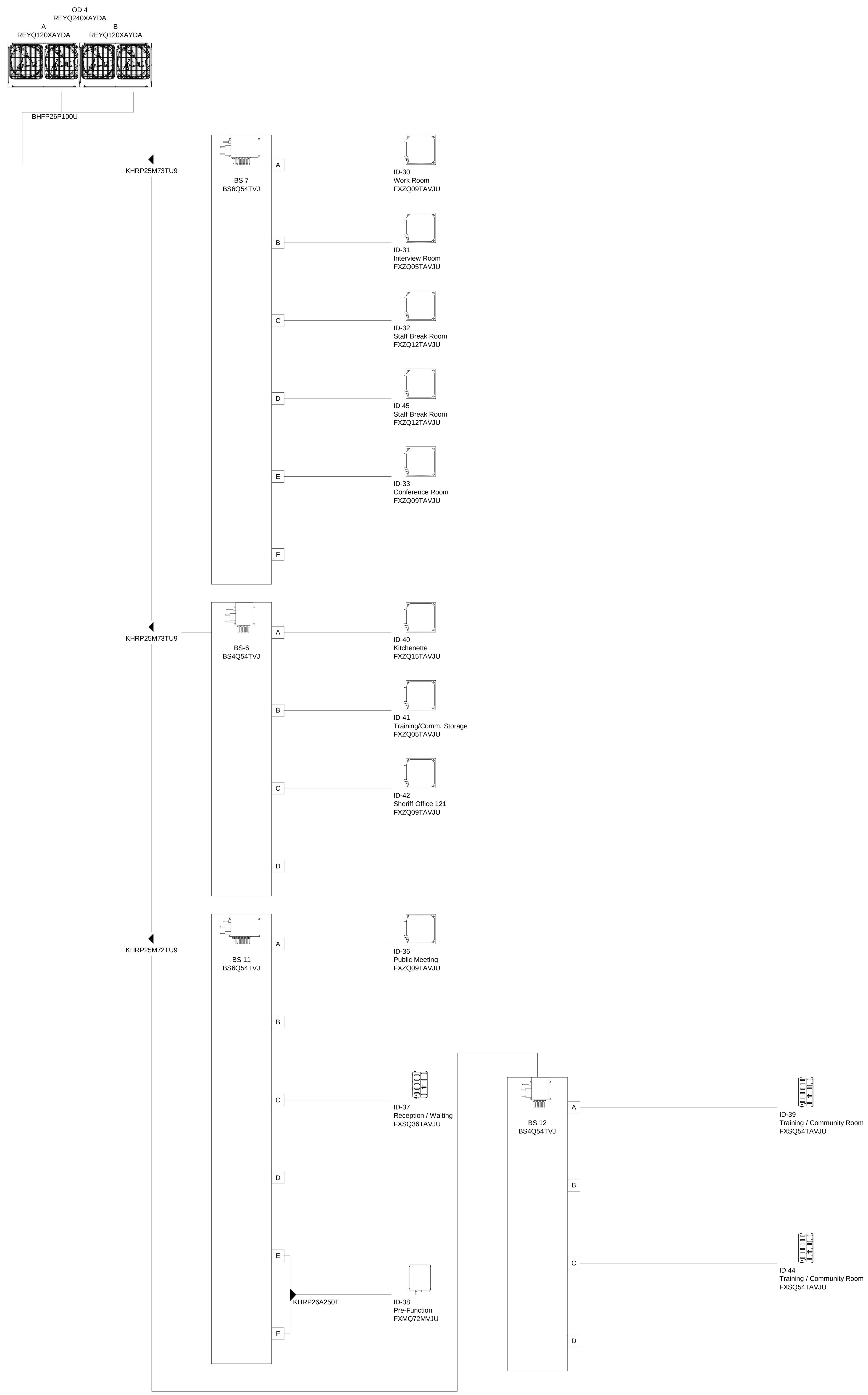
TITLE

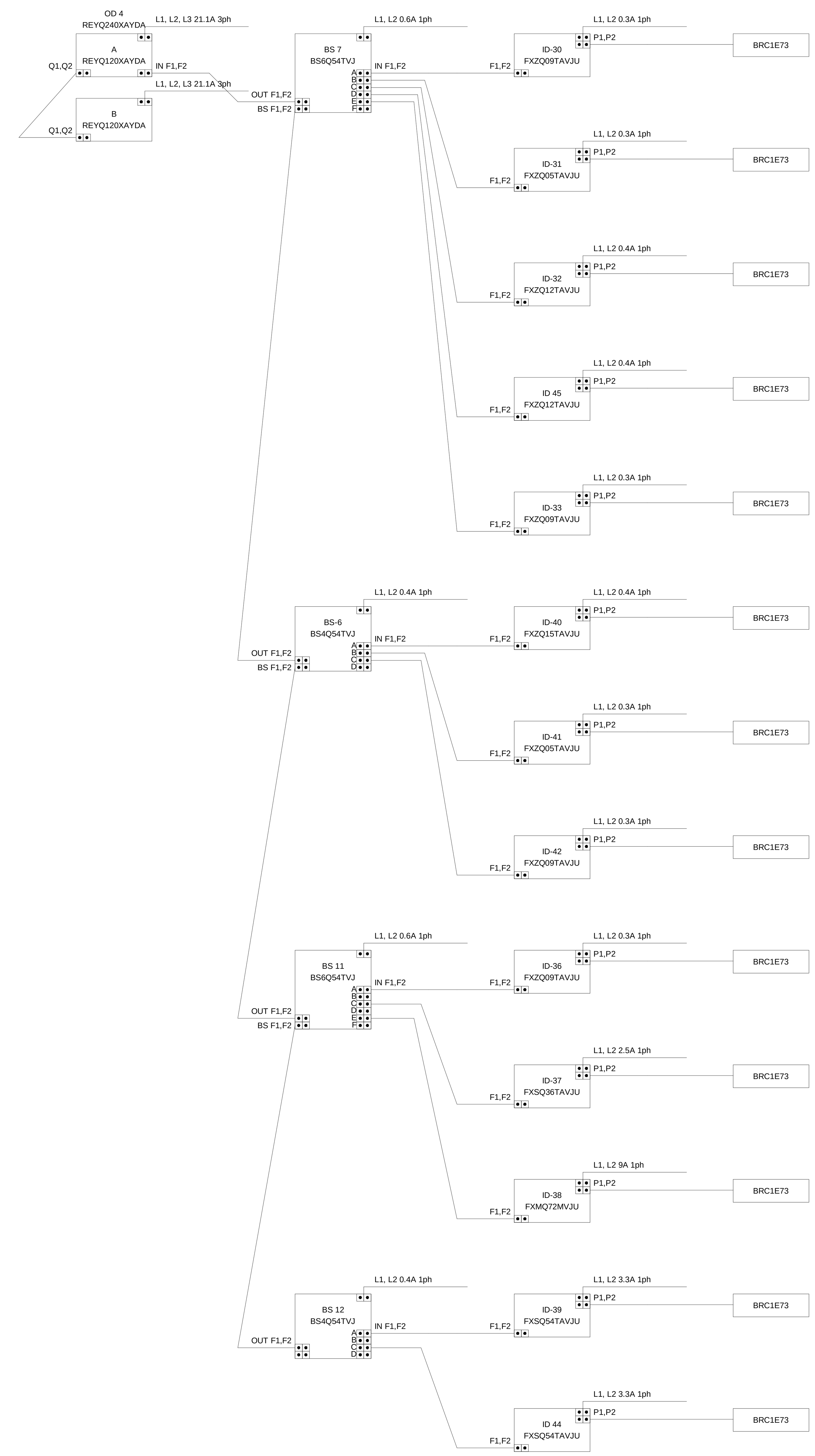
OD-3 PIPING AND WIRING

DRAWING NUMBER

M5.2



OD-4 PIPING
1/8" = 1'-0"



OD-4 WIRING
1/8" = 1'-0"

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OD-4 PIPING AND WIRING

DRAWING NUMBER

M5.3