Bristol Fire Department

Engine Company 5

Bristol, CT

HVAC Evaluation Report

Prepared for:

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Date: September 7, 2021

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Project Number 2020128.00

VANZELM ENGINEERS

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I. EXECUTIVE SUMMARY

In December of 2020, van Zelm was hired as an independent consultant to perform a study of the HVAC systems at the Bristol Firehouse 5 located at 285 Mix Street Bristol, CT.

The scope of work for the study included the following:

1. **Design Review:**

   A. Provide a comprehensive evaluation of the mechanical systems design.

   B. Determine if the installed systems are capable of meeting the owner's needs.

2. **Installation & Operational Assessment:**

   A. Determine if the systems are installed correctly and per the design drawings.

   B. Test systems to determine if they are setup and operating correctly per the design intent and capable of meeting the needs of the owner.

   C. Visually inspect building envelope.

3. **Final Report:**

   A. Executive summary with an overview of operational problems, causes, and recommended remedial work.

   B. Facility description with general configuration of equipment.

   C. Tables with equipment and measurement data.

   D. Description of operational problems, analysis undertaken, and likely causes of problems.

   E. Description of recommendations for modifications to address deficiencies and resolve operational problems.

5. **Work performed:**

   A. Review of the available documentation provided.

   B. Meetings to discuss the issues and complaints.

   C. Site visits to determine the actual installed equipment and systems.

   D. Investigation and monitoring of the building HVAC system.

   E. Observation and measurement of airflows, temperature and relative humidity levels.

   F. Investigation of the Kitchen Ventilation equipment.

   G. Testing and adjusting of equipment settings.

6. **History**

A. The single-story building was built in 1966. The building was renovated in 2015-2016 and a small addition was added. The mechanical systems were completely replaced as part of the renovation. The building currently has approximately 4,277 square feet of living space.

B. The conditioned space is served by two packaged cooling only roof top units. Each unit has a hot water heating duct coil installed below the unit. There is a programable thermostat for control of each system. RTU 2 serves the Dorm Room area and RTU 1 serves the Kitchen, Day Room and Office area. The Apparatus Bay and Garage areas do not have air conditioning.

C. The small kitchen is fitted out as a full commercial kitchen. There is a restaurant quality stove, griddle, oven installed. A commercial grease hood is installed above the cooking apparatus. The Kitchen Hood Exhaust Fan is a side wall fan located on the south wall of the Kitchen. The Kitchen Hood Makeup Air Unit is located on the roof. It is a natural gas fired unit with no cooling capacity.

D. There have been complaints about temperature control and high relative humidity since the renovation. The complaints also include condensation dripping from diffusers and in some cases light fixtures and the ceiling grid.

E. It has been reported that attempts to identify the cause and rectify the problem by the project team and others. Some modifications were apparently made including additional duct insulation and additional sealing between walls and the roof deck.

F. van Zelm Engineers was asked to review the HVAC system to determine the problems and make recommendations to correct the issues.

7. **Statement of Findings:**

Our investigation confirmed that the HVAC systems are capable of cooling the spaces under most conditions. The interaction of the Kitchen ventilation equipment and the HVAC systems is seen as the main component of the temperature and humidity concerns.

We have made temporary modifications to the system that have greatly improved the environmental conditions to satisfactory levels in the conditioned space. There has been ongoing interaction with the occupants to determine the effectiveness of these changes. The feedback has been positive.

The building envelope has a deficient vapor barrier that occasionally allows the relative humidity above the Dorm Room ceilings to become excessive and leads to condensation on the ductwork. This problem has been mostly alleviated by the mechanical system changes but it was observed once after the changes were completed.

II. DESIGN REVIEW

1. The design review phase of this project consisted of the following:

   A. Architectural and Mechanical drawings dated 8/24/2015 were provided and reviewed.

   B. A letter from the Mechanical Engineer dated August 18, 2020 detailing a site visit with the mechanical contractor was also reviewed.

   C. The Architect was DRA, Inc. from South Windsor, CT The Mechanical Engineer was RZ Design Associates, Inc from Rocky Hill, CT.

   D. Mechanical Equipment

   The installed systems in the table below were confirmed to be consistent with the design drawings.

Table 1

Unit	MFG	Model	Area Served	Capacity
RTU 2	Trane	4TCY 4024A 1000 BA	Dorm Rooms	2 Ton
RTU 1	Trane	4TCY 4024A 1000 BA	Day Room, Office, Kitchen	2 Ton
EF 1	Cook	70 ACE	Toilet/Storage Rooms	150 CFM
EF 2	Cook	80 ACE	Weight Room	500 CFM
EF 3	Cook	100 ACE	Garage Storage	785 CFM
EF 4	Cook	165 ACE	Apparatus Bay	1,800 CFM
Kitchen Hood	CaptiveAire	4824 ND-2	Stove/Grill	N/A
KEF 1	CaptiveAire	DU50HFA	Kitchen Hood	1,125 CFM
KMUA 1	CaptiveAire	D76	Kitchen Hood	900 CFM

III. SYSTEM OPERATIONAL ASSESSMENT

1. We performed extensive investigation and testing as noted below during this phase of the project.

   A. We visited the site several times from March 3, 2021 to July 15, 2021. These visits allowed us to monitor and observe the equipment operation and indoor conditions under a variety of outside conditions. These conditions included heat waves as well as cooler more humid days. We were also able to interact with different people on different days which allowed for varied feedback.

   B. As part of this study, we performed testing and made adjustments in a measured, incremental fashion so that each change could be evaluated on its own as to the effectiveness it had on the comfort in the building.

   C. In March, we became familiar with the building and performed air flow and room pressure testing between the Apparatus Bay and the conditioned space. The March 3, 2021 Field Notes are included in Section V of this report. The results of the room pressure, testing at the time, indicated that the Apparatus Bay was not having a large effect on the air-conditioned space. We also made subsequent measurements of airflow and pressurization.

   D. Equipment Observations

      1. Outside Air

         a. The outside air dampers on the RTUs were not opening. The two position dampers are sized for 25% of the total unit flow which would be about 200 CFM of outside air at full flow. The mechanical schedule calls for 150 CFM for each RTU.

         b. Our initial airflow measurements were done in March when there was not a call for heating or cooling. With the outside air dampers closed, our supply and return air flow measurements calculated to 84 CFM of outside air for the Dorm RTU 2 and 52 CFM of outdoor air for the Day Room RTU 1.

         c. We calculated the required ventilation rates for each system based on the floor area, type of room and 3 people occupying the building. Our calculations indicated the required volume of outside air to be 30 CFM for the Dorm RTU 2 and 50 CFM for the Day Room RTU 1.

      2. Toilet Exhaust Fan EF-1

         a. The Toilet exhaust fan is not operating. We checked the fan and found the fan motor needs to be replaced.

      3. The Garage Exhaust Fan EF- 3

         a. The fan is not operating. This should be investigated and corrected.

4. The Weight Room Exhaust EF-2

   a. The fan is not needed. There are no walls for the Weight Room and it is essentially part of the Apparatus Bay.

5. The Apparatus Bay Exhaust fan EF 4

   a. We found the circuit breaker off and the ceiling thermostat set to 60°F. We turned the breaker on and set the ceiling thermostat to 83°F. which we feel is more appropriate.

6. Dorm RTU 2 Thermostat

   a. We found the relative humidity reading unreliable on this thermostat.

7. Dorm Room Airflow

   a. The rooms are small and the supply and return diffusers and registers are in close proximity. There is some air recirculation taking place from the supply to the return.

8. Dayroom Thermostat

   a. The thermostat located where there is a slight influence from the supply diffuser.

9. Dayroom/Office Air Flow

   a. We found the majority of the return air was from the office return register. We adjusted the return air flow to increase the return from the Dayroom and reduce the return from the Office. There was only one damper to work with but we were able to better match the supply air in each room. This was done to improve the conditions in the office.

   b. An additional volume damper would be needed to close off the office return further to completely correct the imbalance of supply and return.

10. Kitchen Hood Makeup Air Unit

    a. The unit was off. The disconnect on the roof was off and the gas valve was closed. We noted the same condition was found by the engineer in August 2021. In our discussions with the staff, it sounds like the unit has not been used because it blows cold air in the winter and hot air in the summer.

11. Building Envelope

    a. Our visual inspection of the building envelope indicated what looked like attempts at installing additional sealing between the walls and roof deck in some areas. Our testing seemed to indicate the wall between the Apparatus Bay and the occupied areas was not the source of the problem. Airflow was from the occupied area toward the Apparatus Bay due to the very slight pressure difference.

b. The south facing outside wall appears to be partially responsible for the complaints. When we inspected the wall above the ceiling, the upper portion above the sheetrock, was warm and very humid. This was later determined to be a problem only during the extremely rainy July days. We did not see the issue to this extent in June which was warmer and not as rainy.

c. We feel this is the source of any remaining condensation issues. Throughout most of our study, after we made adjustments, the condensation problem appeared to have ended. It was during one of our later site visits that we discovered the ducts above the Dorm Rooms were covered with condensation. There was not a problem above the corridor ceiling or the Kitchen and Dayroom ceilings.

E. Equipment Modification Testing

1. After the initial observations, we began the testing process by setting the system up as close to design as the equipment would allow.

2. We had already established that the Apparatus Bay had a far less effect on the conditioned space than we would have expected but we were now able to confirm that the bay doors being open or closed also did not seem to have much impact on the conditions in the occupied areas.

3. We manually opened the defective RTU outside air dampers. We had always been concerned about building pressurization and offsetting the exhaust air was the goal.

4. We turned the Kitchen Hood Makeup Air Unit on but left the gas valve off as found.

5. Kitchen Hood Operation

    a. When we tested with the hood off and on, we began to see that the cooling capacity was actually lager than the load under operating conditions when the hood was off. This was evidenced by the fact that the room temperature setpoint, which is kept very low by the occupants, was being satisfied.

    b. With the hood operating, the temperature would rise above setpoint and the humidity would increase. The rooms would stay in this condition for a long period of time after the hood was turned off. So, under this condition, the capacity was on the low side as evidenced by the unit struggling to recover.

    c. Both conditions are problematic. The over capacity condition causes the cooling to cycle too often which reduces the dehumidification capability of the unit. Obviously, the inability of the unit to recover quickly enough is also a problem.

6. Roof Top Unit Airflow

    a. The roof top units have ECM fan motors and the fan speed is varied based on the cooling demand. The factory setting is 400 CFM per ton.

    b. We found them set to the maximum of 450 CFM per ton.

c. To improve the dehumidification capability of the units, we reduced this setting to the minimum of 350 CFM per ton. This change allows the units to run longer in cooling before they satisfy and cycle off. This change was done at the RTU by changing the DIP switch settings on one of the unit control circuit boards.

7. Under these conditions the temperature and relative humidity responded well with the hood off.

8. During another site visit, we noticed that the relative humidity was rising quickly when the RTU would cycle the cooling off. We closed the outside air dampers that had been manually opened due to the failed actuators, to a minimal position. This reduced the amount of outside air being introduced and later in the day there were no longer signs of condensation on the supply diffusers. With the amount of outside air previously measured due to damper leakage, we feel the dampers can be left closed completely and still deliver the code required volume of outside air for ventilation.

9. However, when the hood was operating, the makeup air was influencing the room temperature and not all being exhausted as it should have been. The reports were that the room temperature was being influenced by the make up air and the room temperature had gotten very high and took hours to recover.

10. We then measured the hood airflow, both the exhaust and the makeup air. We found the exhaust was less than the makeup air. This is consistent with the reports that the hood had been adjusted. The exhaust was measured at 907 CFM and the makeup air was measured at 965 CFM. The makeup air fan is constant speed while the exhaust fan is variable speed. We can understand why this may have been done. It may have been to reduce the exhaust closer to the RTU supply and the make up air but it did not have positive results.

11. Typical hood airflows have the makeup air at 80% of the exhaust and this is consistent with the mechanical schedule but had seemingly been adjusted differently.

12. We adjusted the exhaust airflow to bring it up to 1,149 CFM, slightly above design, to get closer to the typical ratio of 80%. The reports from that evening were that they had to turn off the makeup air unit because the room temperature was rising. The now increased exhaust was not allowing the rooms to remain cool when the hood was being operated. The hood exhaust was overcoming the RTU supply air capacity so more air was being exhausted than could be supplied.

13. Having proven the HVAC and Kitchen ventilation will not work together as intended, we took a different approach. The Kitchen is not used as a commercial kitchen. There are generally just three people that cook for themselves.

14. We shut off the makeup air unit which the occupants elect not to use because of the issues. We also temporarily reduced the volume of kitchen exhaust air. We determined the new volume by heating oil on the griddle and observing the smoke. The exhaust airflow was set to a volume that was visibly capturing and exhausting the smoke. The system has been operating like this since June 29, 2021. The feedback has been generally positive. There was one instance where it was reported that the hood did not exhaust the smoke. It is possible the hood was not actually running at that time. The hood operation is not audible at this reduced volume and it must be verified by looking at the controller. A note may be required to check

that the fan is operating before cooking. The temperature and humidity have been cool and dry while operating in this fashion.

15. On a July 15, 2021 follow up site visit, we discovered condensation on the supply and return ducts above the Dorm Room ceilings. We had not seen this condition when we looked on previous inspections. The issue was confined to above the Dorm Rooms. The Corridor and the Kitchen/Dayroom had no issue. It should be noted that this has been an extremely wet and humid month of July where it has rained almost every day. It was not raining at this time but the sun had come out and was steaming the moisture in the lawn outside the building.

    The outside conditions were 86.9°F and 53.3% RH.
    The Dayroom setpoint was 69°F and the room temperature was 69°F with 58% RH
    The Dorm setpoint was 68°F and the room temperature was 68°F and 63% RH.
    We measured the relative humidity above the dorm room ceiling at 78.2°F and 93.7% RH.
    The sheetrock on the wall stops about 12" below the roof deck in some rooms and the mineral wool seemed slightly damp and warm. There does not appear to be an adequate vapor barrier at this wall.

IV. FINDINGS AND RECOMMENDATIONS

1. The temporary changes we have made seem to have improved the environmental conditions to satisfactory levels. The slight changes to the RTU airflow configuration and the outside air volume have improved the relative humidity levels and condensation problem during normal operation, when the kitchen hood is off. The changes made to the hood exhaust, improved the overall conditions in the space while the hood is operating.

2. The temperature setpoints are being set by the occupants to settings far below what would be typical for cooling. They are also below the engineer's recommended setpoint of 75°F. The temperature setpoints are typically set at or below 70°F particurly in the Dorm.

   Even at these low temperatures, the relative humidity is normally at about 58% in the Dayroom and 63% in the Dorm. We understand that the occupants are going to set the setpoint to where they think is comfortable.

   The equipment now seems capable of maintaining even these artificially low setpoints under the current operating conditions. These low temperatures, do however, increase the relative humidity levels. These low settings also contribute to condensation forming on the duct above the ceiling and on the supply diffusers.

   We strongly recommend that the thermostats not be set below 70°F. as an absolute minimum. We believe the thermostats have the capability of being set to limit the range the occupants can set them to should that be desired.

3. We had initially recommended that the RTU fresh air dampers be repaired but we now believe the code required volume of outside air is being met or exceeded through damper leakage alone. Repairing the dampers to function as the unit design operates them, will have a negative affect on the unit performance and building comfort due to the high than required volume of outside air the unit will deliver.

4. The way the kitchen ventilation system has been operated, with the Makeup Air unit not being allowed to operate, is not code compliant. The temporary change made to the Kitchen ventilation equipment is also technically not meeting the code requirements for commercial kitchen ventilation equipment. However, the kitchen is not being used as a commercial kitchen and the exhaust fan operation is now similar to that of a large range hood. The authority having jurisdiction should comment on the present arrangement.

5. The system will not meet the needs of the occupants with the Kitchen ventilation set to operate as intended. If the Kitchen ventilation needs to operate as designed, the HVAC system will need to be modified to account for the higher exhaust flows and unconditioned makeup air during the time the kitchen equipment is operated. This could involve replacing the kitchen ventilation

system and equipment or adding additional HVAC equipment to be used only during the time that cooking is taking place.

6. The Toilet exhaust fan motor needs to be replaced.

7. The condensation on the ductwork above the Dorm Ceiling now only seems to only happen during extreme humid weather. It is related to the building envelope construction. This condition must be addressed so that condensation is not allowed to form on the duct. The simplest way to address the condensation problem may be the installation of an exhaust fan to exhaust air from the space above the ceiling. This could be controlled by a humidistat or a thermostat and would reduce any moisture build up.

8. The lack of an effective vapor barrier, however, may have other long-term implications to the building. van Zelm has confirmed there is a problem and consideration should be given to having further inspections to determine the extent of the issue and what would be required to correct the deficiency. This may require more than a visual inspection to determine what is or is not actually installed as part of the wall system.

9. The RTU airflow measurements and pressurization measurements are found as part of Table 1 below. The Kitchen exhaust and Makeup Air measurements are found in Tables 2 and 3. The revised Exhaust measurements are found in Table 4.

V. FIELD NOTES

Bristol Firehouse 5 site visit

March 3, 2021

Met Peter Fusco and David Oakes at 9:30. David and I spent a few hours looking at things.

RTU 1	Trane	4TCY402A1000BA	16076KC29H	2/2016
CaptiveAire		D76	900 CFM	
EF 4	Cook 165 ACE	165C4B	1800 CFM	
EF 2	Cook 80 ACE	80C3B	500 CFM	
EF 3	Cook 100ACE	100C3B	785 CFM	
RTU 2	Trane	4TCY402A1000BA	16064JSF9H	2/2016
EF 1	70 ACE70C3B		150 CFM	

Existing Plymovent 3 drops

MUA unit disconnect off and gas valve closed.

Toilet Exhaust Fan not running.

Apparatus Bay exhaust fan breaker off.

Weight Room walls were removed as part of reno. It's basically part of the Apparatus Bay so the associated EF is probably not needed.

Exhaust fans have thermostats on the ceiling. They are not manual control as indicated on drawings. The main garage EF was set to 60°F.

They reportedly don't touch the exhaust fans and, in the summer, they do open all of the bay doors.

The complaints are about dripping condensate and not so much temperature as humidity, but that wasn't fully clear.

Wall between Apparatus Bay and living area is sealed with mineral wool at roof deck. Some fire caulking has been done but not the entire area. Mostly sealed to some degree and insulated. This wall is assumed to have no vapor barrier. The outside wall is undetermined at this point.

The duct insulation was reported to have been redone. The top of the diffusers has been insulated.

Evidence of the diffusers sweating. It was reported that they are still sweating after the duct insulation modification.

Bathroom ceiling tiles are thin, hard and water resistant. Other rooms are typical tiles. Dorm doors are well undercut. The proximity of the supply and return in the dorm rooms is very close. Probable recirculation. Should use Wizard Stick to confirm.

Corridor doors to the garage and Apparatus Bay have sweeps.

It was reported that the kitchen hood has been adjusted several times. The MUA is at the at the ceiling just in front of the hood. Cold air used to blow down as they were cooking. This firehouse is occupied continuously and they cook three times a day. Not sure if it is the MUA or EA that has been adjusted.

The two RTUs have programmable thermostats. The dorm one had the fan one. The other had the fan in auto. I forgot to set that back to auto. Setpoints were 68/74.

There is a stat in the end dorm room and in the dining area.

Measured Air Flows

RTU 2	**SA**	**RA**	**EA**	
Dorm 109	94	112		
Corridor	62			
Dorm 108	80	135		
Dorm 107	87	115		
Dorm 106	95	110		This room is an office, not a dorm room.
Corridor	60			
Women's	70		0	
Total	**SA=556**	**RA=472**	**Calc OA=84**	

RTU 1	**SA**	**RA**	**EA**
Men's	59		0
Dayroom 102	107		
	97		
	156		156
Office 101	112	323	
Total	**SA=531**	**RA=479**	**Calc OA=52**

Measured Pressures

ΔP Across Apparatus Bay Door to Corridor

	Kit Hood	**MUA**	**RTU 1**	**RTU 2**	**Garage EF**	**Garage Door**
-.0020	On	Off	On	On	Off	Closed
+.0049	On	Off	On	On	On	Closed
-.0049	On	Off	On	On	Off	Closed
-.0171	On	Off	On	On	Off	Open
-.0115	On	Off	On	On	On	Open
-.0022	Off	Off	On	On	On	Open
+.0059	Off	Off	On	On	On	Closed
-.0003	Off	Off	On	On	Off	Closed
-.0001	Off	Off	On	On	Off	Open
-.0036						

Positive tube in corridor. Negative tube in garage. Indicating a slight negative in the occupied space with respect to the garage.

Need to recheck with the MUA unit running and the Toilet exhaust fan on.
Some simple balancing may help. Maybe reduce the return in the dorm rooms and add some to the corridor to minimize recirculation. Possibly move the supply to the outside wall. The Office has far too much return for the amount of supply. Need to check everything in the cooling season.

VI. KITCHEN HOOD AIRFLOW MEASURMENTS AND ADJUSTMENTS

Table 2

Exhaust Baffle Filter CFM Worksheet for Shortridge VelGrid

Job Number =	2020128.00		rev. 5	
Job Name =	Bristol Engine Company 5			
Date =	June 28, 2021			
Hood Number 1 Information 60 Hz				
Model = 4824-ND2		Length = 5'		
	Filter #1	**Filter #2**	**Filter #3**	**Total CFM**
Filter Size	16" x 16"	16" x 16"	16" x 16"	No Filter
Velocity	190	187	183	
CFM	308	303	296	907
Notes: As Found .84Amps 1156 RPM 60Hz				
Hood Number 1 Information 70 Hz				
Model = 4824-ND2		Length = 5'		
	Filter #1	**Filter #2**	**Filter #3**	**Total CFM**
Filter Size	16" x 16"	16" x 16"	16" x 16"	No Filter
Velocity	218	215	197	
CFM	353	348	319	1021
Notes:1.22 Amps After 1343 RPM 70 Hz				
Hood Number 1 Information 75 Hz				
Model = 4824-ND2		Length = 5'		
	Filter #1	**Filter #2**	**Filter #3**	**Total CFM**
Filter Size	16" x 16"	16" x 16"	16" x 16"	No Filter
Velocity	247	240	210	
CFM	400	389	340	1129
Notes: 75 Hz				
Hood Number 1 Information 78 Hz				
Model = 4824-ND2		Length = 5'		
	Filter #1	**Filter #2**	**Filter #3**	**Total CFM**
Filter Size	16" x 16"	16" x 16"	16" x 16"	No Filter
Velocity	259	234	216	
CFM	420	379	350	1149
Notes:1.57 Amps 1478 RPM 78 Hz				

Filter Information

Reference	Filter Size	Free Area	K Factor*
1	No Filter	0	0
2	10" x 16"	0.78	1.2
3	10" x 20"	0.99	1.2
4	12" x 12"	0.69	1.2
5	12" x 16"	0.97	1.2
6	12" x 20"	1.25	1.2
7	12" x 24"	1.52	1.2
8	16" x 16"	1.35	1.2
9	16" x 20"	1.73	1.2
10	16" x 25"	2.22	1.2
11	20" x 20"	2.23	1.2
12	20" x 25"	2.85	1.2
13	24" x 24"	3.36	1.2

*NOTE: K-Factor Is the same for all Baffle style filters.

The fan was set to 60 Hertz which measured 907 CFM. The frequency was incrementally increased and the corresponding airflow was measured. The design CFM is 1,125 but the Makeup Air is elevated so the fan speed was increased beyond design to 78 Hz to match the ratio of Makeup Air.

Table 3

PSP Supply CFM Worksheet for Shortridge VelGrid						
Job Number =	2020128.00				rev. 10	
Job Name =	Bristol Engine Company 5					
June 28, 2021						
PSP Number 1 Information						
PSP Length =	73	inches	Notes:	KMUA-1		
PSP Width =	14	inches				
Number of Blanks =						
	Reading #1	Reading #2	Reading #3	Reading #4	Reading #5	CFM
Velocity	164	166	135	166	146	965
Total Supply CFM's =	965	CFM				

PSP Information			
Reference	PSP Width	Free Area	K Factor
1	0	0	0
2	6	0.5	0.83
3	9	0.75	0.83
4	10	0.833	0.83
5	12	1	0.83
6	14	1.167	0.9
7	16	1.333	0.9
8	18	1.5	0.9
9	20	1.667	0.9
10	24	2	0.9

The Makeup Air unit is constant volume. There was no adjustment capability.

Table 4

Exhaust Baffle Filter CFM Worksheet for Shortridge VelGrid				
Job Number =	2020128.00		rev. 5	
Job Name =	Bristol Engine Company 5			
June 29, 2021				
Hood Number 1 Information				
Model = 4828 ND-2		Length = 5'		
	Filter #1	Filter #2	Filter #3	Total CFM
Filter Size	16" x 16"	16" x 16"	16" x 16"	No Filter
Velocity	77	82	74	
CFM	125	133	120	377
Notes: 30 Hz 586 RPM				
Reduced Airflow with no Makeup Air for Improved Environmental Control				

Filter Information			
Reference	Filter Size	Free Area	K Factor*
1	No Filter	0	0
2	10" x 16"	0.78	1.2
3	10" x 20"	0.99	1.2
4	12" x 12"	0.69	1.2
5	12" x 16"	0.97	1.2
6	12" x 20"	1.25	1.2
7	12" x 24"	1.52	1.2
8	16" x 16"	1.35	1.2
9	16" x 20"	1.73	1.2

*NOTE: K-Factor Is the same for all Baffle

This is the temporary exhaust airflow with out the Makeup Air unit operating.