

Project: City of Mesquite Animal Shelter
HVAC System Assessment

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Background:

Reed, Wells, Benson and Company was commissioned by the City of Mesquite to assess the existing air conditioning system serving the Mesquite Animal Shelter, specifically the kennel area, and recommend actions necessary to improve operation, comfort and odors. This may also include the need for replacement of the system serving the kennel area, as applicable. The facilities department for the city had received numerous complaints regarding comfort, odors and high humidity levels in the kennel area.

Findings:

There is one large 100% dedicated outside air unit that serves all of the kennel area. All air supplied to this area is exhausted to the outdoors. This unit was relocated from the original design location which resulted in the outside air intake being a relatively short distance from the kennel exhaust air louver. This may contribute to recirculation of exhaust air into this unit.

The supply air to the kennel area is broken into five (5) separate zones, each one with a gas fired duct furnace as follows:

<u>Zone #</u>	<u>Serves</u>
1	North Kennels (Interior)
2	South Kennels (Interior)
3	Kennel Corridors (Interior, North & South)
4	North Support Areas (Vet Tech/Work Room)
5	East Quarantine Area

The performance data for this 100% outside air unit includes entering and leaving air conditions from the original submittal which was for a "Munters" Model HCU 8000 (submitted and installed) manufactured unit which does not match the design conditions as shown in the original schedule. The basis of design was provided by Baird, Hampton & Brown, Inc., Engineering & Surveying in the construction documents issued on May 24, 2004.



EQUIPMENT DATA SHEET	
MANUFACTURER	MUNTERS DRYCOOL
MODEL NUMBER	HCU8000
DESIGN DATA	
OUTSIDE AMBIENT (DB / GR-LB)	86 / 89
SUPPLY AIRFLOW (SCFM)	8,000
MAKE UP AIR VOLUME (SCFM)	8,000
SUPPLY FAN	
SIZE	18-18
TYPE/CLASS	BAF / I
AIR VOLUME (SCFM)	8,000
TOTAL STATIC PRESSURE (WG")	3.73
MAXIMUM EXTERNAL STATIC	1.50
FAN RPM	1760
MOTOR HP	10
REACTIVATION FAN	
SIZE	18-18
TYPE/CLASS	BAF / I
AIR VOLUME (SCFM)	8,000
TOTAL STATIC PRESSURE (WG")	2.02
FAN RPM	810
MOTOR HP	7.5
DESICCANT WHEEL	
PRESSURE DROP PROCESS (WG")	1.23
PRESSURE DROP REACTIVATION (WG")	1.39
REACTIVATION HEATED TO TEMP.	115
COOLING COIL	
REFRIGERANT TYPE	R-22
TOTAL CAPACITY	40 TONS
COIL CIRCUITS	1
ROWS / FPI	6 / 12
FACE AREA (SQ. FT)	21.8
COIL P (WG")	0.62
CONDENSER	
COMPRESSORS / HP	40
STAGES OF CAPACITY	2
COIL FACE AREA	64.6
ROWS / FPI	3 / 15
CONDENSER FAN HP	1.5
CONDENSER FAN RPM	1140

Figure No. 1: Original Unit Submittal Performance Data Sheet

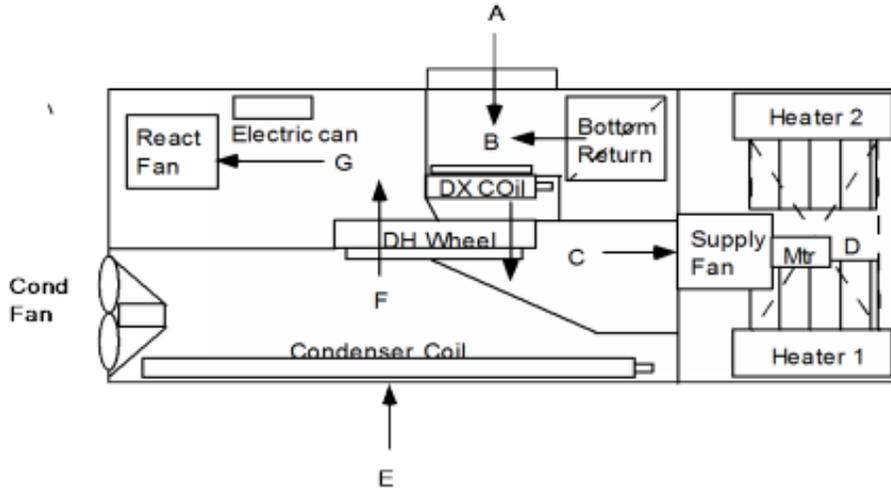


Figure No. 2: Original Installed Unit Configuration

	Entering Conditions			Leaving Conditions			
SUMMER	A	B	C	D	E	F	LBS / HR Removed
CFM	8000	8000	8000	8000	8000	8000	290
TEMP DEG F	86	86	68	70	86	115	-
GR / LB	89	89	33	33	89	89	-
WINTER							
CFM	8000	8000	8000	8000	-	-	
TEMP DEG F	20	20	20	94	-	-	
GR / LB	-	-	-	-	-	-	

Figure No. 3: Original Unit Installed Performance Data

OUTSIDE AIR UNIT														
TAG NO.	SUPPLY FAN			REACTIVATION FAN			CONDENSER FANS		COMPRESSORS		PERFORMANCE			
	CFM	HP	ESP IN W.G.	CFM	HP	ESP IN W.G.			NO.	HP	ENT. CONDITIONS		LVG. CONDITIONS	
											D.B. °F	GR./LB	D.B. °F	GR./LB
OAU-1	8350	10	1.5	8250	7.5	1.0	(1) AT 1.5 HP	(1) AT 2 HP	4	10.0	82	135	74	55

Figure No. 4: Original Unit Design Schedule Requirements

The floor plan supply air flow totals 8,350 cubic feet per minute (CFM) which matches the design schedule. The submittal data was based on 8,000 CFM. The outside air unit design includes 135 grains per pound of dry air as the basis of design which is consistent with the peak dehumidification moisture level encountered in this area. The coincident dry bulb temperature of 82.0 degrees F. is actually higher than normal for this moisture level (74.0 – 76.0 degrees F. is more typical). The design includes cooling the outside air down to 74 degrees F. and a humidity ratio of 55 grains. This would be equivalent to an indoor relative humidity of approximately 45% RH. No test data was found which documents actual installed unit performance.

The original design exhaust and supply airflow rates for the kennel area is 8,350 cubic feet per minute (CFM) which equates to 11 air changes per hour (ACH) for the space. This ventilation rate exceeds the minimum of 7.5 CFM per person and 0.18 CFM per square foot of outdoor air, or 0.9 CFM per square foot of exhaust air, required by the 2015 International Mechanical Code (IMC) for pet shops (similar use) and is within the guidelines of 10 to 15 ACH recommended by the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC). The Design Requirements Manual of the National Institute of Health (NIH), however, recommends a minimum ventilation rate of 15 ACH for animal research facilities, although this facility is not a research facility. Based on our review of multiple resources related to this matter, the consensus recommended ventilation rate range is 10 to 15 ACH for municipal animal shelters and kennels. The current design meets the minimum requirements. However, actual performance could fall under this level. A higher ACH would be desirable, but not required.

Table 7 Ventilation rates in Animal Research Facilities (1)

Facilities	Minimum Air Changes per Hour (2) ACH
Small Animal, Static Cage/Rack	15
Small Animal, Ventilated Cage/Rack	10
Large Animal	15
Aquatics (zebra fish)	6 (3)
Office / Administration Support	6 (4)
Laboratories	6

Notes:

- (1) Ventilation rates refer to 100% outside air
- (2) Or higher to support fume hood and BSC demands and high heat loads
- (3) Typical ventilation rate ranges from 6 to 9 air changes per hour
- (4) Or 9 L/s (20 cfm) per person, whichever is greater

Figure No. 5: NIH Design Requirements

The nameplate on the installed outdoor air unit indicates 30% pleated air filters are used for the make-up (supply) air system. This meets the minimum filtration level for this type of system and application.

FILTERS			
FILTER TYPE	30% PLEATED		
	MAKE-UP	MAKE-UP	REACT
QUANTITY	4	4	6
SIZE	20X20X2	20X25X2	16X25X2

Figure No. 6: Filters Listed on Installed Outdoor Air Unit Nameplate

In a related American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) presentation on the design of animal research facilities, filtered exhaust grilles (may also be needed if energy recovery devices are used) and high efficiency particulate air (HEPA) filtration were listed as design considerations. For a municipal kennel facility, we do not believe this is necessary.

Design Considerations



- HVAC Design
 - Location of inlets/outlet
 - Filtered exhaust grilles (30% eff.)
 - Locate ductwork to avoid damage
 - HEPA Filtration
 - Supply
 - Exhaust
 - Air Exchanges
 - 10-15 ACH - AAALAC Standard
 - 15-20 ACH - Canadian Standard
 - Design to space loads - ASHRAE

Species	Weight, lb	Heat Generation, Btu/h per Normally Active Animal		
		Sensible	Latent	Total
Mouse	0.046	1.11	0.54	1.65
Hamster	0.260	4.02	1.98	6.00
Rat	0.62	7.77	3.83	11.6
Guinea pig	0.90	10.2	5.03	15.2
Rabbit	5.41	39.2	19.3	58.5
Cat	6.61	45.6	22.5	68.1
Nonhuman primate	12.0	71.3	35.1	106.0
Dog	22.7	105.0	56.4	161.0
Dog	50.0	231.0	124.0	355.0

ASHRAE Handbook Applications – Heat Generated by Laboratory Animals

Species	ACH
Cat	10-18
Dog	8-12
Gerbil	8-10
Horse	4-8
Mouse	8-12
Non-Human Primate*	10-16
Rat	10-20
Swine	15-20

CCAC – Housing and Environment Appendix C

University of Illinois - Large Animal Clinic Animal Holding

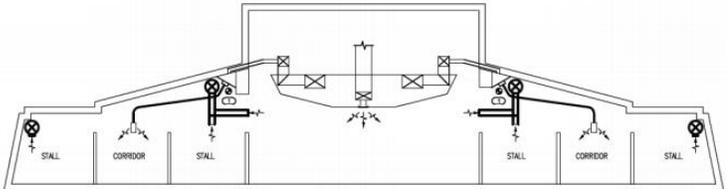


Figure No. 7: Summary of Design Considerations for Research Animal Facilities

(ASHRAE Illinois Chapter Presentation)

The location of the exhaust louver for EF-3 as shown on the original mechanical design documents and in the photo below, Figure No. 8, may not meet the code required 10 ft. minimum separation distance from the intake of the outdoor air unit. The outdoor air unit was initially located around the corner from this louver as per the original design drawings which was acceptable. The current condition exposes the system to recirculation of air from the kennel back into the ventilation unit. In any upgrade or equipment replacement this condition should be corrected.



Figure No. 8: Photo of Installed Equipment

Conclusions:

Based on the submitted unit performance data, as compared to the original design requirements, the existing outdoor air unit does not have the capacity to remove enough moisture from the air on very humid, peak design dehumidification days. The original design schedule lists the entering humidity ratio as 135 gr/lb and the leaving humidity ratio of 55 gr/lb (a difference of 80 gr/lb). The performance data from the submittal on the original unit shows an entering humidity ratio of 89 gr/lb and a leaving humidity ratio of 33 gr/lb (a difference of 57 gr/lb). Therefore, the installed unit is deficient in dehumidification capacity per the design and cannot maintain acceptable indoor relative humidity levels.

The location of one (1) exhaust louver in close proximity to the intake for the outdoor air unit may be allowing for the introduction of odors and pet dander into the make-up air system.

The actual exchange rate of air in the kennels is on the low side of that recommended and is marginally acceptable.

The air filters installed in the outside air unit appear to be basic minimum efficiency (30%) pleated media filters. It would be desirable to have higher quality type filters installed in this unit.

The regular kennel area and quarantine kennel area are served by the same outside air unit. This is not a desirable condition.

Recommendations:

The outdoor air unit should be replaced with a model that meets the peak dehumidification design conditions. Energy recovery is an option to consider for reducing the cooling capacity of the replacement unit, or units. The physical size would be similar or larger than the existing unit. To incorporate energy recovery, it may also be desirable to split the outside air system into two (2) units to correspond to the two (2) separate exhaust systems.

It would also be recommended to provide two (2) separate outside air units such that one unit serves the main kennel area and the second unit would serve the quarantine area.

If the outside air unit is replaced but stays in its current location, either a hood should be installed at the exhaust louver location near the outdoor air unit that deflects exhaust air away from the outdoor air unit intake, or the unit should be re-oriented to have the outside air intake further away from the exhaust.

HEPA filters could also be installed in the exhaust ductwork near the exhaust louvers which would help prevent the spread of animal dander, fur, and odors to the outside. This would require duct modifications, addition of filters and possible exhaust fan motor adjustments (larger fans to address higher static air pressure losses). This would be an enhancement but optional.

The new replacement 100% outside air unit, or units, should incorporate better air filters in the unit(s); MERV 11 or better filters are recommended.

When any work is performed it should include having the system tested, adjusted and balanced (TAB), as well as having the system commissioned.