



FACILITY EVALUATION

MARSHALL COUNTY JUDICIAL BUILDING

Executive Report

80 Judicial Drive
Benton, KY 42025

March 16, 2019

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EXECUTIVE SUMMARY

Based on initial feedback from Mr. Brad Warning- Marshall County Fiscal Court Deputy Judge Executive, we understand that the Marshall County Judicial Building has experienced persistent indoor air quality concerns made manifest by visible mold growth in the Summer of 2018. This issue was substantiated via environmental air sampling conducted on August 1st, 2018 and incorporated herein for reference (Appendix A).

A review of the available system history and onsite observations suggest that contemporary operational performance of the energy-recovery ventilator (ERV) unit tagged ERV-1 is at least a significant contributor to the performance degradation, coupled with systemic rainwater intrusion into the basement via exterior telecommunications pathways, periodic interior hydronic and condensate leaks and miscellaneous exterior building envelope items of note.

BACKGROUND INFORMATION

On August 28th, 2018, we were contacted by Mr. Brad Warning – Marshall County Fiscal Court Deputy Judge Executive regarding indoor air quality concerns relative to the Marshall County Judicial Building. In particular, Mr. Warning made us aware that the facility had recently experienced a proliferation of visible mold growth which had primarily impacted the ground floor District Judges' office suite.

We solicited a copy of the building floor plans, which we received on August 29th, 2018.

After an initial cursory review of the facility on August 29th, 2018, two (2) items were identified as warranting further evaluation, namely:

1. Per the '*Exterior Waterproofing and Interior Water Damage Repair*' drawings (c. 2011 included in Appendix B) The exterior wall envelope does not appear to incorporate:
 - a. Brick veneer cavity drainage nor venting.
 - b. Continuous air barrier nor vapor retarder.
2. Per Original Construction Drawing H-2.1 (included in Appendix B) it would appear that the building is capable of operating in a negative volumetric offset of approximately <-3,900> CFM when including the effect of the exhaust fan tagged VF-1, which is scheduled for 5,000 CFM of exhaust and serves the connecting corridor between the Judicial Building and the Detention Center. If the equipment is in-fact operating in this manner, it could present opportunities for uncontrolled infiltration of ambient air which could lead to excessive vapor migration into the building envelope and interstices.

Additionally, we solicited copies of the Final Test and Balance Report (Appendix C) and we were provided an electronic copy of the same by Ms. Mary Wagner- Administrative Assistant with Thermal Balance on February 28th, 2019.

SYSTEM EVALUATION AND RECOMMENDATIONS

On Wednesday, February 27th, 2019 we were able to conduct an onsite assessment of the current conditions at the Marshall County Judicial Building. We were assisted by Mr. Gary Teckenbrock- Marshall County Fiscal Court Maintenance Supervisor. At approximately 9:01 a.m. CST the ambient temperature and relative humidity were recorded in the parking lot at 50° F / 61% R.H., which equates to an ambient enthalpy of approximately 17.11 Btu/lb.

Observation #1- Facility Volumetric Air Balance

During the visit, space temperature, relative humidity, supply and return air temperature and space pressure relative to the ambient were measured for several spaces with exterior profiles and recorded as follows:

Space	Space Temp.	Space R.H.	S.A. Temp.	R.A. Temp.	Space R.P.
Receiving Area	64°F	35%	N/A	N/A	-0.021 in. H20
Mechanical Room	71°F	49%	N/A	N/A	-0.028 in. H20
Main Entry Vestibule	63°F	43%	69°F	66°F	-0.009 in. H20
Security Lobby	66°F	41%	71°F	70°F	-0.005 in. H20
County Atty. Office	74°F	33%	73°F	73°F	-0.018 in. H20
Exit Lobby	72°F	33%	74°F	76°F	-0.024 in. H20
Secure Corridor (Det.)	64°F	40%	N/A	N/A	+0.007 in. H20
Secure Corridor (Jud.)	66°F	39%	N/A	N/A	-0.005 in. H20
Employee Entrance	67°F	36%	69°F	67°F	-0.017 in. H20
Dist. Judge Conf.	73°F	35%	70°F	70°F	-0.007 in. H20
Dist. Judge Chamb.	64°F	50%	64°F	66°F	-0.014 in. H20
Fam. Judge Chamb.	69°F	35%	70°F	69°F	-0.008 in. H20
Cir. Judge Chamb.	70°F	38%	67°F	73°F	± variable

These data suggest two prevalent conditions, namely:

1. The building as-a-whole appears to be currently operating at a net negative pressure relative to ambient pressure. This issue appears to be more pronounced on the North side of the facility in general.
2. It appears that both the Judicial Building and the Detention Center are negative relative to the connecting corridor in their current respective operational states. Based on this observation, it might be expected that the bulk of this make-up air is being brought in via the roof-mounted intake hoods at each end of the connecting corridor.

Based on these findings, we advised the Fiscal Court that it would be prudent to conduct a follow-up Test and Balance exercise on the rooftop ventilation-air unit tagged ERV-1. On Thursday, May 14th, 2019 Mr. Steve Brown, Test and Balance Technician with Thermal Balance, Incorporated conducted this effort (*Appendix D*). Upon arrival, he observed that the metal prefilters serving the unit were severely occluded with accumulated debris (*Figure 1*). Prior to removing the metal prefilters, the total ventilation supply-air rate was 1,551 CFM and the total exhaust-air rate was 4,566 CFM, resulting in a <3,015> CFM volumetric offset. Upon removing the metal prefilters, the total ventilation supply-air rate increased to 4,332 CFM, resulting in a <234> CFM volumetric offset. These results are summarized in *Appendix E*.



Figure 1

Observation #2- Energy Recovery Ventilator Performance

Based on initial site observations relative to the energy recovery ventilator tagged ERV-1 (outlined in *Observation #1* above) contact was made with the manufacturer's representative (R.L. Craig Company, Inc.) for the energy-recovery ventilator (Greenheck) currently installed at the Marshall County Judicial Building.

Mr. Shane Leavell, Vice President indicated that while the original selection was no longer in archives, he could recreate the selection for our use and evaluation (*Appendix F*).

In particular, our focus was on the resultant energy content (enthalpy) that the unit was capable of producing at design cooling conditions (95°F db and 78°F wb).

As noted on page 6 of 13 of the '*ERV Submittal*' that the predicted 'Supply Air' enthalpy at the specified design cooling conditions is 33.0 BTU/lb.

To put this in perspective, here are some typical interior space conditions and their accompanying enthalpies:

Temperature (°F db)	Relative Humidity (%)	Enthalpy (BTU/lb)
72	50	26.77
72	60	28.70
74	50	27.93
74	60	30.00

What this seeks to underscore is that delivering ventilation-air with an enthalpy of 33.0 BTU/lb. induces a non-trivial amount of space load and resultant moisture burden that must be effectively managed during hot and humid outside conditions. To demonstrate this point, we can hold enthalpy constant at 33.0 BTU/lb. and temperature constant at 72° F db and 74° F db respectively and can calculate the resultant relative humidity:

Temperature (°F db)	Enthalpy (BTU/lb)	Relative Humidity (%)
72	33.0	82.0
74	33.0	74.5

The resultant enthalpy differential assuming preferred space conditions of 74°F and 50% relative humidity is outlined in *Appendix G*.

Observation #3- Rainwater Intrusion

While onsite, we observed several locations within the basement area which either previously or are currently experiencing periodic rainwater intrusion (see *Figure 2*). Of particular note is what appears to be a significant leak through the two (2) telecommunications conduit pathways entering a basement space referred to as '*Evidence Storage*'. The significant rainfall event of March 13th and 14th confirmed this, when rainwater was observed by Mr. Gary Teckenbrock entering the space from the interior of one (1) of the pathways in question.



Figure 2

Based on these findings, we advised the Fiscal Court that it would be prudent to engage AT+T (telephone) and Spectrum Communications (cable television) in an effort to successfully remediate this concern.

On Wednesday, March 13th, Mr. Gary Teckenbrock and I met with AT+T's installation subcontractor (Star Construction). After a brief consultation, they manually excavated at the pole in the Southwest corner of the property to expose both the telephone and cable TV conduits (two (2) parallel 4" Ø conduits- see *Figure 3*). Following, Mr. Mike Huffmaster with AT+T came by to inspect the conduit end serving as the pathway for the telephone service and judged it to be sufficiently sealed against water intrusion. At the time of this writing, technicians from Spectrum Communications are scheduled to conduct a site evaluation of the exposed communications conduit serving the cable TV connection at 1:00 p.m. CDT on Friday, March 22nd.



Figure 3

Observation #4- Interior Hydronic and Condensate Leaks

While onsite, we observed several locations within the facility which appear to have experienced periodic hydronic and/or condensate leaks. The most pronounced example of this was observed in the workroom adjacent to the Circuit Judges' reception area (*Figure 4*).



Figure 4

Observation #5- Building Envelope Concerns

Based on onsite evaluations, there were three (3) prevalent observations of note:

1. There appear to be brick vents installed periodically throughout the brick veneer, but most appear to have been sealed over- presumably by the brick sealing process executed in 2011. *Figure 5* identifies an open brick vent found above-grade on the East side of the facility and *Figure 6* identifies the typical application of sealant media over a location containing a brick vent.



Figure 5



Figure 6

2. There does not appear to be a vapor barrier installed within the envelope cross-section in the very limited areas open and available for review from the interior. *Figure 7* is a photo from the interior of the District Judges' chambers and is typical for the locations where the interior gypsum wall board has been removed for evaluation.

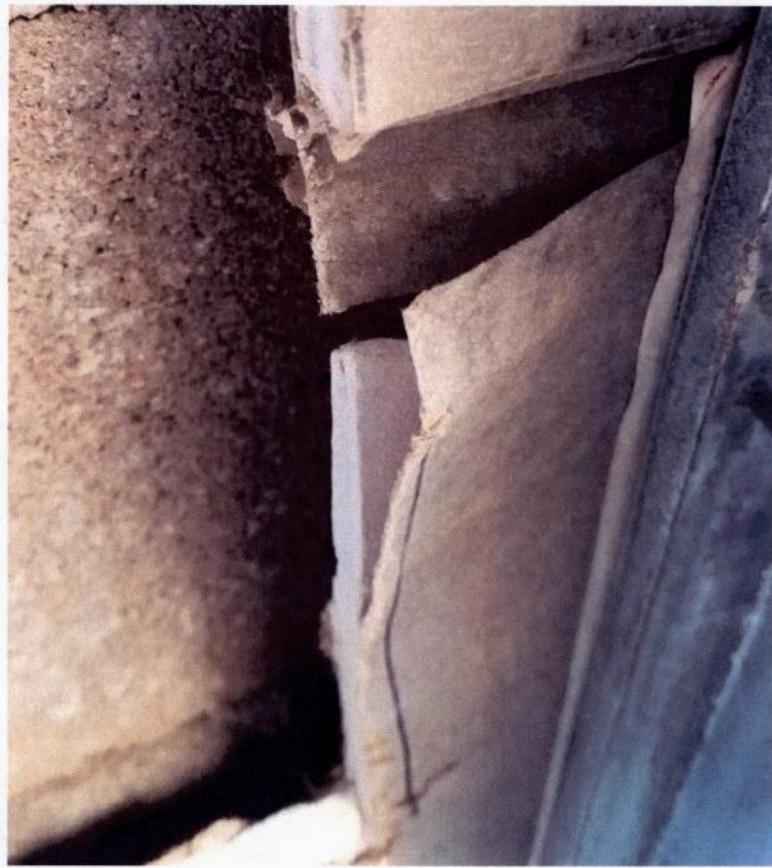


Figure 7

3. There appear to be numerous instances along the scope of the exterior envelope where voids, connections, penetrations, etc. are open and could present opportunity for rainwater impingement and/or significant air migration. *Figures 8 thru 11* respectively represent typical observations.



Figure 8



Figure 9



Figure 10



Figure 11

Observation #6- Miscellaneous Items of Note

While onsite, we also observed two (2) other items of note:

1. The basement Secure Corridor was observed to have a noticeable odor or hydraulic oil. A pressure measurement indicated that the Elevator Equipment Room was operating at approximately +0.005 in. H2O versus the basement Secure Corridor.
2. A review of the HVAC Direct Digital Controls system indicated the following:

<u>Heat Pump</u>	<u>Issue</u>
1009	Not communicating with DDC Controls
1020	Not communicating with DDC Controls
1031	Not communicating with DDC Controls
1050	Not communicating with DDC Controls

Based on the cumulative effect of these evaluations and observations, it is our considered opinion that these issues could be organized in the following priorities based on their individual impact upon overall system performance:

Priority #1a- Identify and seal all active above/below grade sources of rainwater intrusion. It is recommended that the cable TV conduit end is appropriately sealed against rainwater intrusion. Should intrusion continue after this end is sealed, it would be judicious to uncover the parallel conduits in progressively closer intervals to the building in an attempt to isolate the breach(es) in the pathways. Should the breach occur under the portion of the building (i.e. Clerk's suite) that is not over the basement it might entail installing a new pathway as an example of the most evasive remediation scope.

Priority #1b- Identify and address all interior hydronic/condensate leaks.

Priority #2a- Successfully address building relative pressure. Reduce both the incoming and outgoing ventilation and exhaust airflows for the unit tagged ERV-1 to the lowest values respectively which will meet the minimum ventilation requirements outlined in ASHRAE Standard 62.1-2010 while assuring a net positive volumetric balance to mitigate uncontrolled infiltration. After further consultation and discussion it may be prudent at this juncture to replace this unit given its age (i.e. ~18 years) and configuration (i.e. no refrigeration-based cooling/dehumidification). If it is decided that the existing unit will remain for an indeterminate period of time, it is recommended that steps are taken to tune the unit up to assure that the unit be configured to deliver more ventilation supply than it exhausts, that the energy recovery ventilator (ERV) wheel is clean and that the metal prefilters are replaced.

Priority #2b- Successfully resolve the DDC controls-related issues noted in Item #6(2) above.

Priority #3- Following (1a/b) and (2a/b), monitor/test for reoccurring indoor air quality issues. If the issue persists following successful resolution of Items #1a/b and #2a/b above, evaluate wall assembly remediation.

APPENDIX A: AUDAS ENVIRONMENTAL ANALYSIS REPORT



The Identification Specialists

Analysis Report
prepared for
Audas Environmental

Report Date: 8/3/2018

Project Name:

Project #: 08184061

SanAir ID#: 18033444



1551 Oakbridge Dr. Suite B | Powhatan, Virginia 23139-8061

888.895.1177 | 804.897.1177 | fax: 804.897.0070 | IAQ@SanAir.com | SanAir.com



SanAir ID Number

18033444

FINAL REPORT

8/3/2018 4:37:23 PM

Name: Audas Environmental
Address: 98A Main Street
Benton, KY 42025
Phone: 270-527-5495

Project Number: 08184061
P.O. Number:
Project Name:
Collected Date: 8/1/2018
Received Date: 8/3/2018 10:10:00 AM

Dear Jason Rylee,

We at SanAir would like to thank you for the work you recently submitted. The 16 sample(s) were received on Friday, August 03, 2018 via FedEx. The final report(s) is enclosed for the following sample(s): 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 1.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

A handwritten signature in black ink that reads "L. Claire Macdonald".

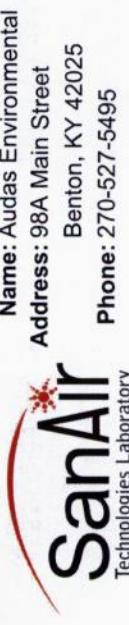
L. Claire Macdonald
Microbiology Laboratory Manager
SanAir Technologies Laboratory

Final Report Includes:

- Cover Letter
- Air Cassette Analysis
- Disclaimers and Additional Information

Sample conditions:

- 16 samples in Good condition.



Project Number: 08184061
P.O. Number:
Project Name:
Collected Date: 8/1/2018
Received Date: 8/3/2018 10:10:00 AM

Analyst: Macdonald, Claire

Air Cassette Analysis

Air Cassette Analysis										ND = None Detected. Blank spaces indicate no spores detected.				
SanAir ID Number	18033444-001	18033444-002	18033444-003	18033444-004	105C	105C	105C	105C	105C	105C	105C	105C	105C	
Analysis Using STL					1	2	3	4						
Sample Number					1st Floor Front Door Control Sample	Outside Back	Outside Front							
Sample Identification														
Sample Type														
Volume					Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	
Analytical Sensitivity					60 Liters	60 Liters	60 Liters	60 Liters	60 Liters	60 Liters	60 Liters	60 Liters	60 Liters	
Background Density					17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	
Other					2	1+	2+	2+	2+	2+	2+	2+	2+	2+
Mycelial Fragments	1	17	n/a											
Fungal Identification														
Acromonium like														
Alternaria species														
Ascospores														
Aspergillus/Penicillium	85	1417	74											
Basidiospores														
Bipolaris/Drechslera														
Cercospora species														
Chaetomium species														
Cladosporium species	12	200	10	272	4533	60	700	128333	90	143	2383	1		
Curvularia species	6	100	5	8	133	2	312	5200	4	19	317	<1		
Epicoccum species				1	17	<1	1	17	<1					
Fusarium species	6	100	5	10	167	2	149	2483	2	11	183	<1		
Nigrospora species							2	33	<1					
Pestalotia- / Pestalotiopsis-like														
Phycomyces species														
Polythrinium species														
Pynularia species														
Rusts	1	17	<1											
Smuts/Myxomycetes	5	83	4	5	83	1	1	17	<1	1	17	<1		
Zygomycota species				2	33	<1	2	33	<1	2	33	<1		
TOTAL	115	1917		455	7583		8591	142850		>12202	>203367			

Signature: *S.Claire Macdonald* Date: 8/3/2018 Reviewed:

Date: 8/3/2018

S.Claire Macdonald



Project Number: 08184061
 P.O. Number:
 Project Name:
 Collected Date: 8/1/2018
 Received Date: 8/3/2018 10:10:00 AM

Analyst: Macdonald, Claire

Air Cassette Analysis

ND = None Detected. Blank spaces indicate no spores detected.

SanAir ID Number	18033444-005	18033444-006	18033444-007	18033444-008
Analysis Using STL	105C	105C	105C	105C
Sample Number	5	6	7	8
Sample Identification	South Hallway Basement	Large Storage Room Basement By Door	Room Behind County Attorney Office 1st Fl	District Court Room
Sample Type	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D
Volume	60 Liters	60 Liters	60 Liters	60 Liters
Analytical Sensitivity	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³
Background Density	2	2	1+	1+
Other	Raw Count	Count/M ³	Count/M ³	Count/M ³
Mycelial Fragments	6	100	n/a	n/a
Fungal Identification		%	Raw Count	Raw Count
Acremonium like			17	33
Alternaria species	1	17	<1	2
Ascospores	404	6733	87	39
Aspergillus/Penicillium	1	17	<1	74
Basidiospores			650	30
Bipolaris/Drechslera				500
Cercospora species				54
Chaetomium species				5
Cladosporium species	49	817	11	6
Curvularia species	5	83	1	5
Epicoccum species			83	9
Fusarium species			100	11
Nigrospora species			2	2
Pestalotiopsis / Pestalotiopsis-like			20	333
Pithomyces species			2	33
Polytrichum species			33	4
Pyrenopeltis species			20	36
Rusts			33	2
Smuts/Myxomycetes	2	33	<1	1
Zygomycota species				17
TOTAL	462	7700	53	883
Signature:	<i>S. Claire Macdonald</i>	Date:	8/3/2018	Reviewed:
				<i>John J. Smith, Jr.</i>
				Date: 8/3/2018



Name: Audas Environmental
Address: 98A Main Street
Benton, KY 42025
Phone: 270-527-5495

Project Number: 08184061
P.O. Number:
Project Name:
Collected Date: 8/1/2018
Received Date: 8/3/2018 10:10:00 AM

Analyst: Macdonald, Claire

Air Cassette Analysis

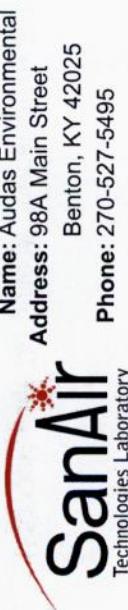
Air Cassette Analysis						
SanAir ID Number	18033444-009	18033444-010	18033444-011	18033444-012	ND = None Detected. Blank spaces indicate no spores detected.	
Analysis Using STL	105C	105C	105C	105C	105C	
Sample Number	9	10	11	12	12	
Sample Identification	1st Floor Driver's License Area	1st Floor Break Room	1st Floor Judge Telle Office	Family Court 2nd Floor	Family Court 2nd Floor	
Sample Type	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	
Volume	60 Liters	60 Liters	60 Liters	60 Liters	60 Liters	
Analytical Sensitivity	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	
Background Density	1+	1+	2+	2+	2+	
Other	Raw Count	Count/M ³	Count/M ³	Count/M ³	Raw Count	Count/M ³
Mycelial Fragments	1	17	n/a	n/a	%	%
Fungal Identification						
Acromonium like					17	<1
Alternaria species					67	2
Ascospores	21	350	84	41	3383	33
Aspergillus/Penicillium					82	33
Basidiospores					2	17
Bipolaris/Drechslera					1	17
Cercospora species						
Chaetomium species	2	33	8	23	203	33
Cladosporium species					67	17
Curvularia species					2	17
Epicoccum species					5	17
Fusarium species					200	17
Nigrospora species					5	17
Pestalotia- / Pestalotiopsis-like					17	17
Pithomyces species					1	17
Polythrinium species					17	17
Pyricularia species					17	17
Rusts					<1	<1
Smuts/Myxomycetes						
Zygomycota species						
TOTAL	25	417	73	1217	249	4150

Signature: *S.Claire Macdonald* Date: 8/3/2018 Reviewed:

Date: 8/3/2018

S.Claire Macdonald

Date: 8/3/2018



Project Number: 08184061
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 Project Name:
 Collected Date: 8/1/2018
 Received Date: 8/3/2018 10:10:00 AM

Analyst: Macdonald, Claire

Air Cassette Analysis

ND = None Detected. Blank spaces indicate no spores detected.

SanAir ID Number	Analysis Using STL	18033444-013	18033444-014	18033444-015	18033444-016
Sample Number	105C	105C	105C	105C	105C
Sample Identification	Circuit Judge Office	2nd Floor Parole Office	2nd Floor Judge Mattingly's Office	Air Cassette - Allergenco-D	Circuit Court Room
Sample Type	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D	Air Cassette - Allergenco-D
Volume	60 Liters	60 Liters	60 Liters	60 Liters	60 Liters
Analytical Sensitivity	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³	17 Count/M ³
Background Density	1+	2+	2+	2+	1+
Other	Raw Count	Count/M ³	%	Raw Count	Count/M ³
Mycelial Fragments	1	17	%	Raw Count	Count/M ³
Fungal Identification				1	17
Acromonium like		1	17	1	17
Alternaria species		1	17	1	17
Ascospores		47	783	56	933
Aspergillus/Penicillium			71	17	79
Basidiospores				1	1
Bipolaris/Drechslera					2
Cercospora species					2
Chaetomium species					33
Cladosporium species					33
Curvularia species					33
Epicoccum species					33
Fusarium species					33
Nigrospora species					33
Pestalotia- / Pestalotiopsis-like					33
Pithomyces species					33
Polythrinium species					33
Pyricularia species					33
Rusts					33
Smuts/Myxomycetes					33
Zygomycota species					33
TOTAL	11	183	66	1100	71
					1183
					6
					100

Signature: *S.Claire Macdonald* Date: 8/3/2018 Reviewed:

Date: 8/3/2018

S.Claire Macdonald

Date: 8/3/2018



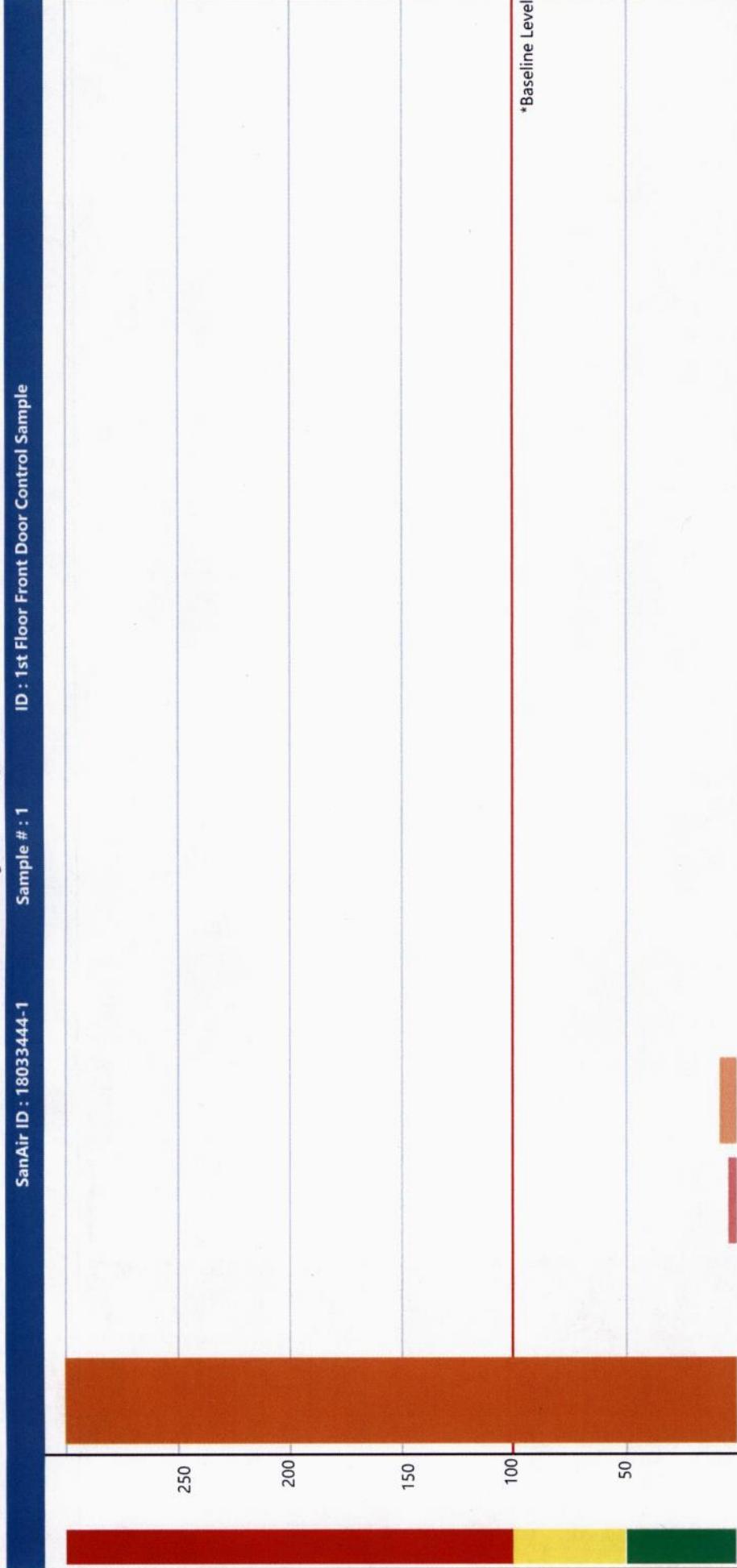
Name: Audas Environmental
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Phone: 270-527-5495

Analyst: Macdonald, Claire

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SanAir ID Number
18033444
FINAL REPORT
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Air Cassette Analysis - Spores % of Outside Air



Count/m³ higher than Baseline	Aspergillus/Penicillium	Cladosporium species	Curvularia species	Fusarium species
Count/m³ comparable to Baseline				
Within 50% of Baseline Count/m³				

*The Baseline Level (100%) represents the average baseline sample counts. Counts above the baseline may indicate higher than expected levels of a given result.



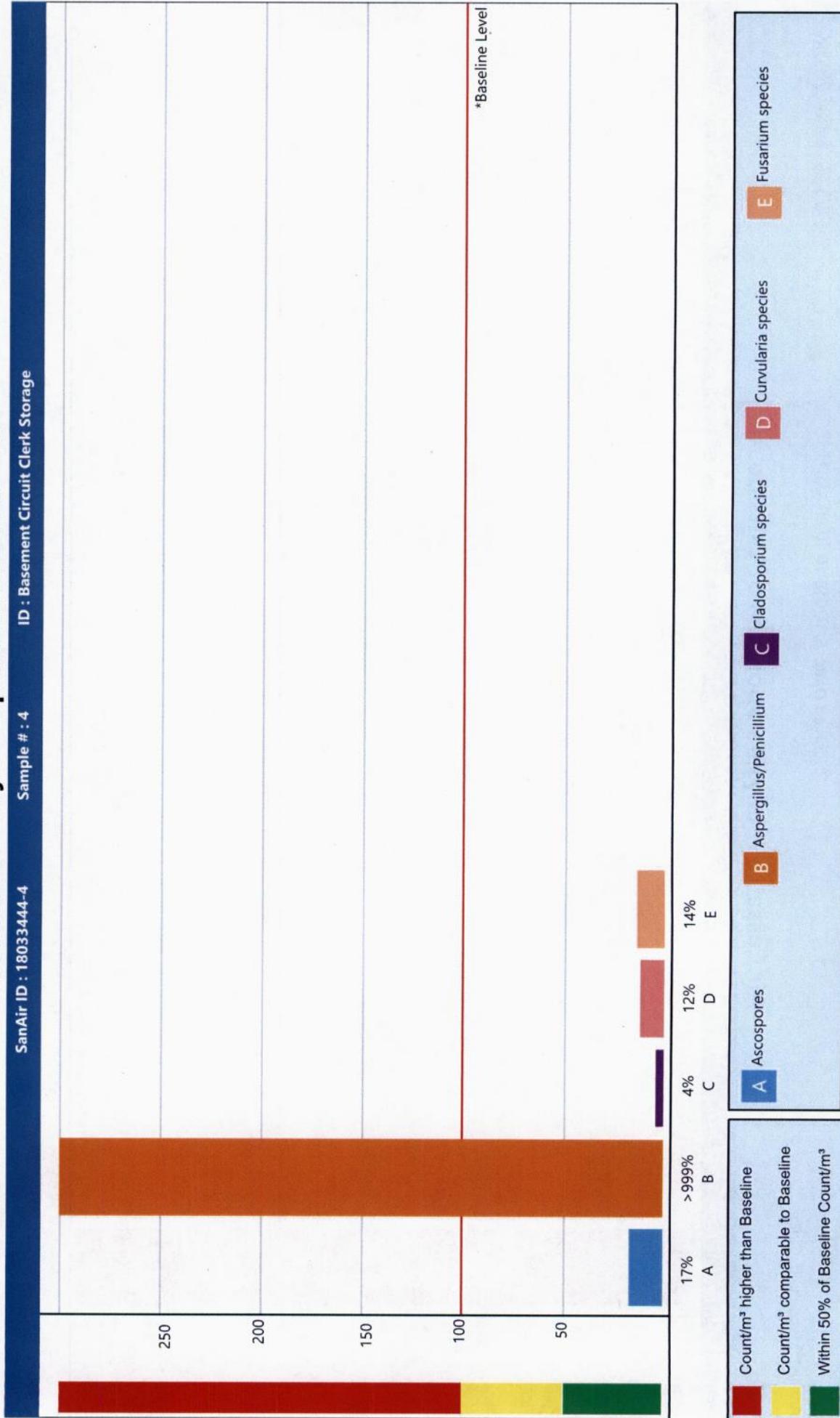
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Analyst: Macdonald, Claire

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8/3/2018 4:37:23 PM

Air Cassette Analysis - Spores % of Outside Air



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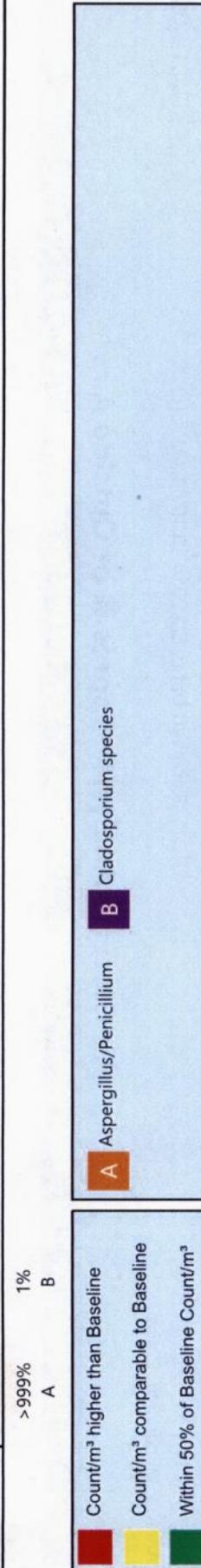
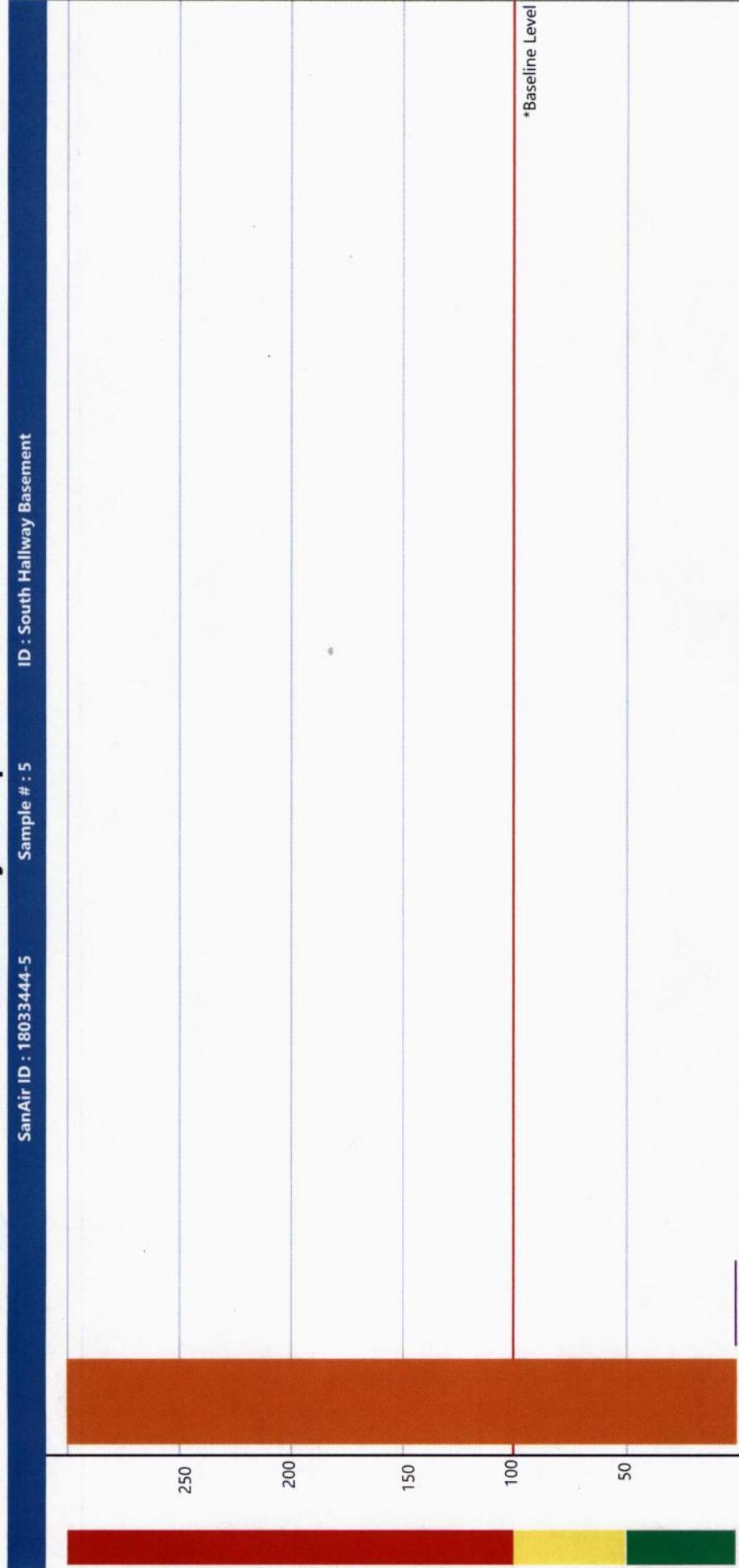
Name: Audas Environmental
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Analyst: Macdonald, Claire

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SanAir ID Number
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FINAL REPORT
8/3/2018 4:37:23 PM

Air Cassette Analysis - Spores % of Outside Air



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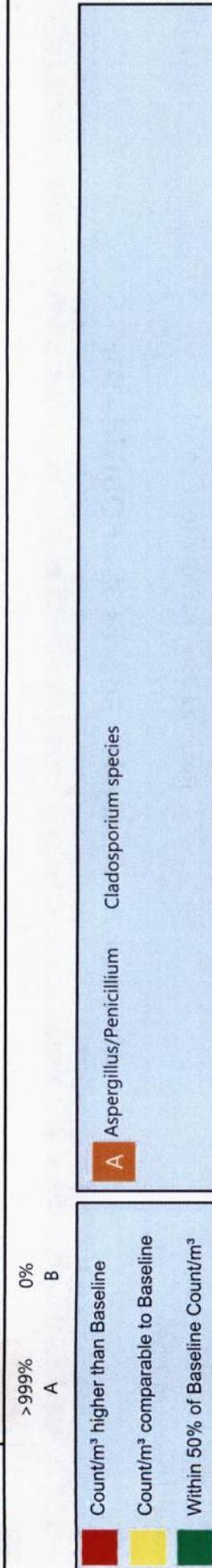
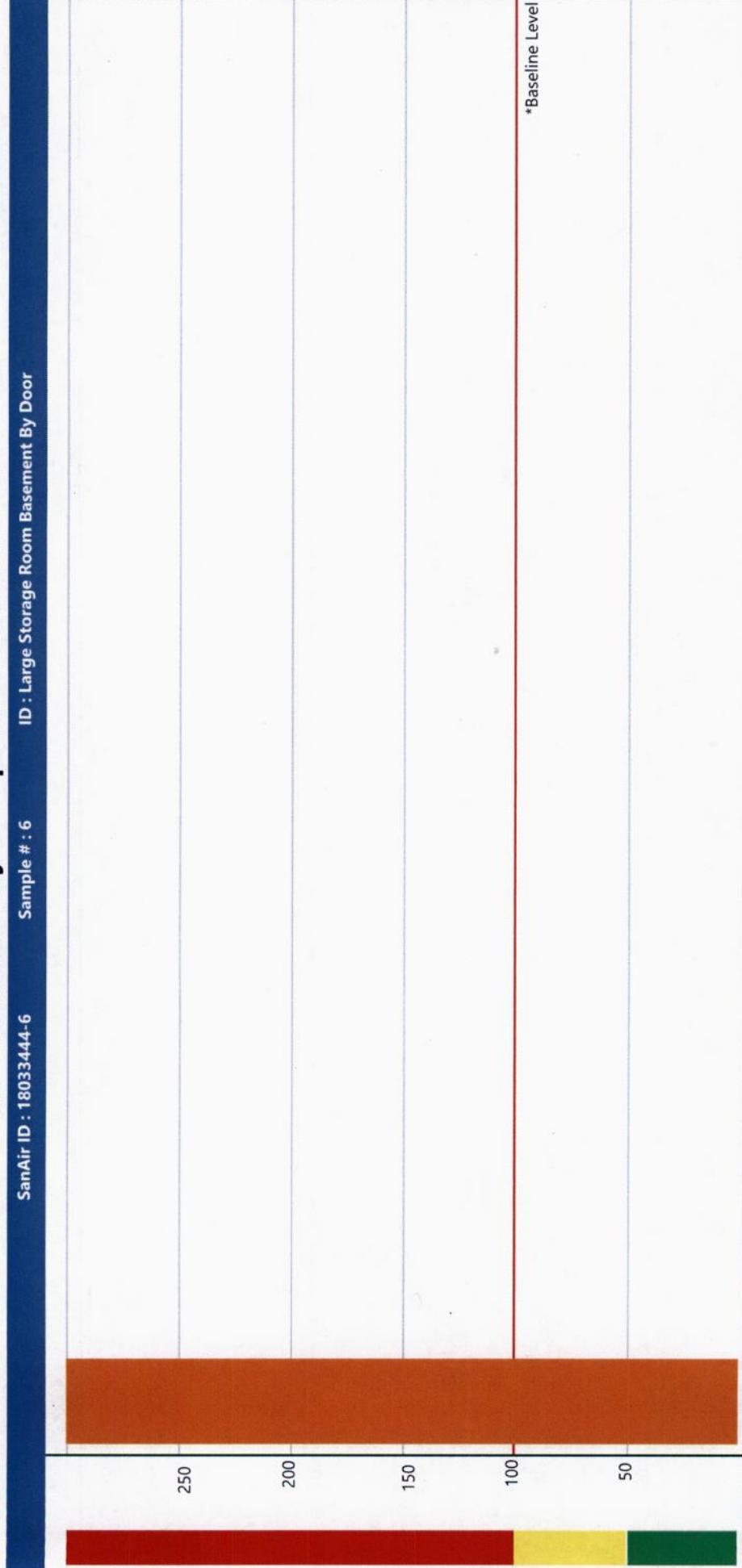
Name: Audas Environmental
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Analyst: Macdonald, Claire

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Air Cassette Analysis - Spores % of Outside Air





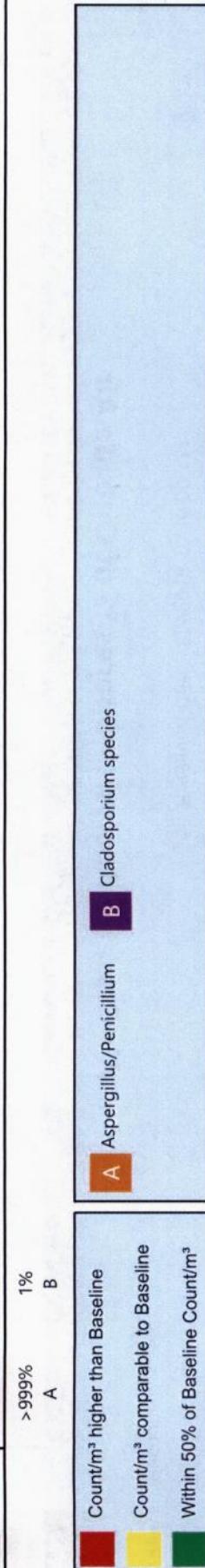
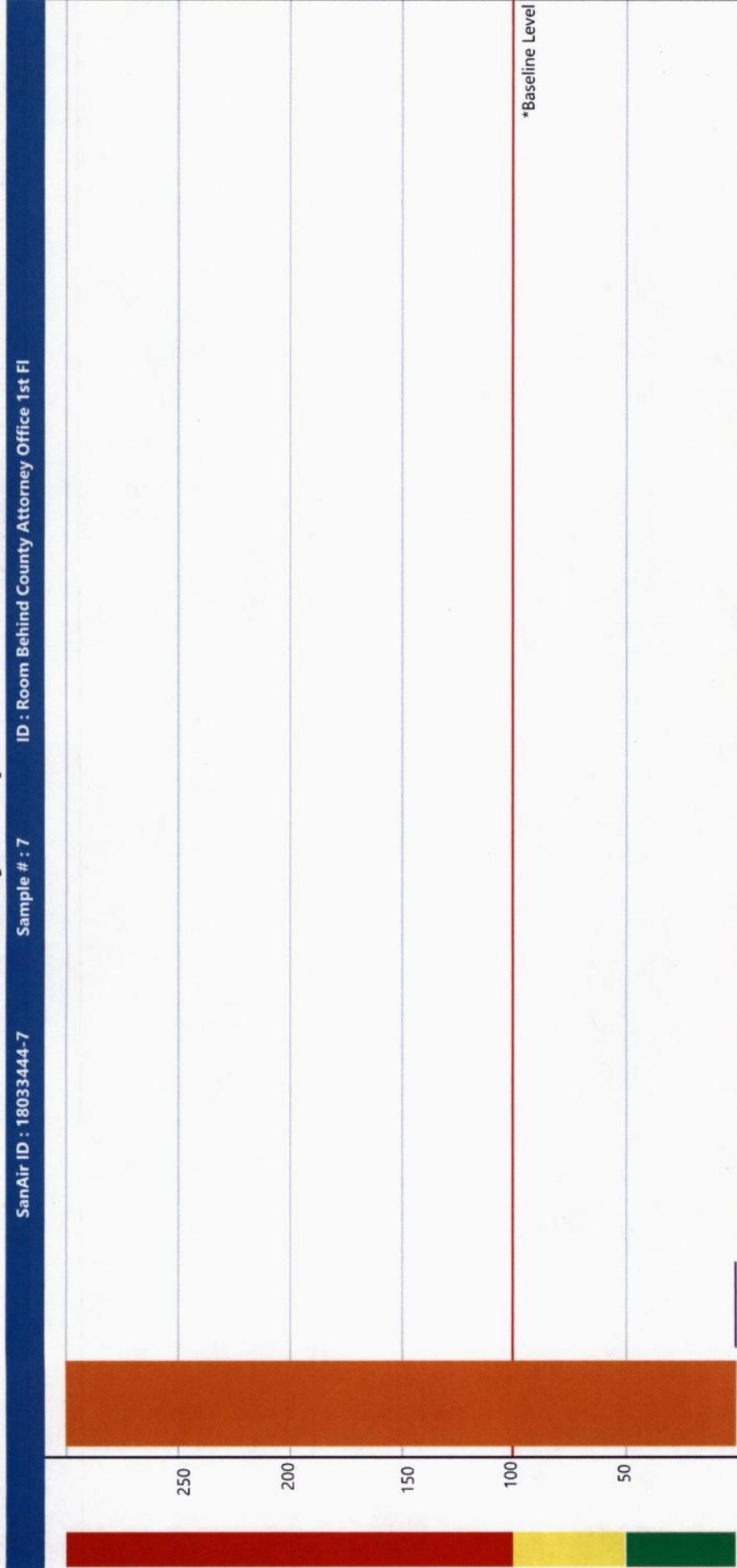
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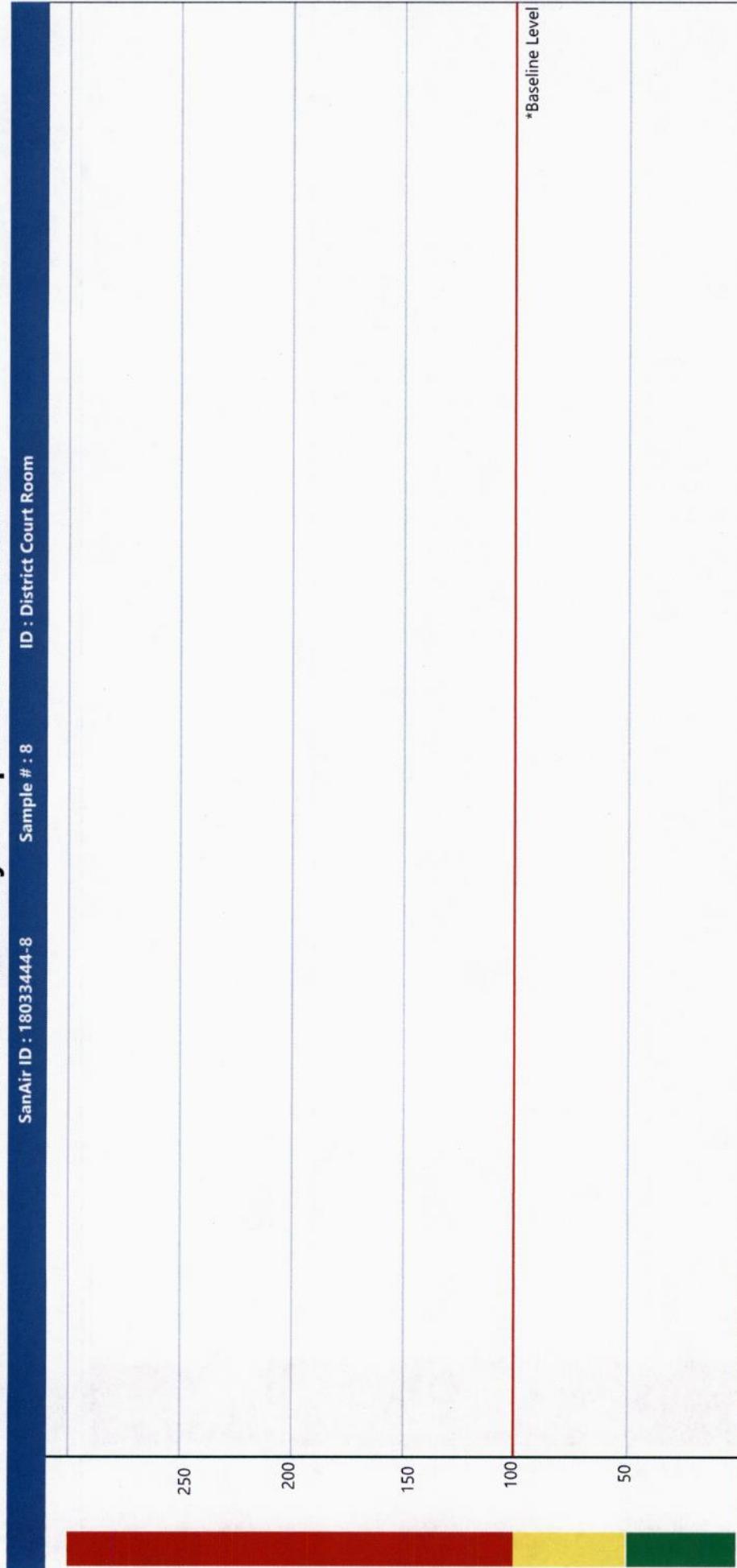
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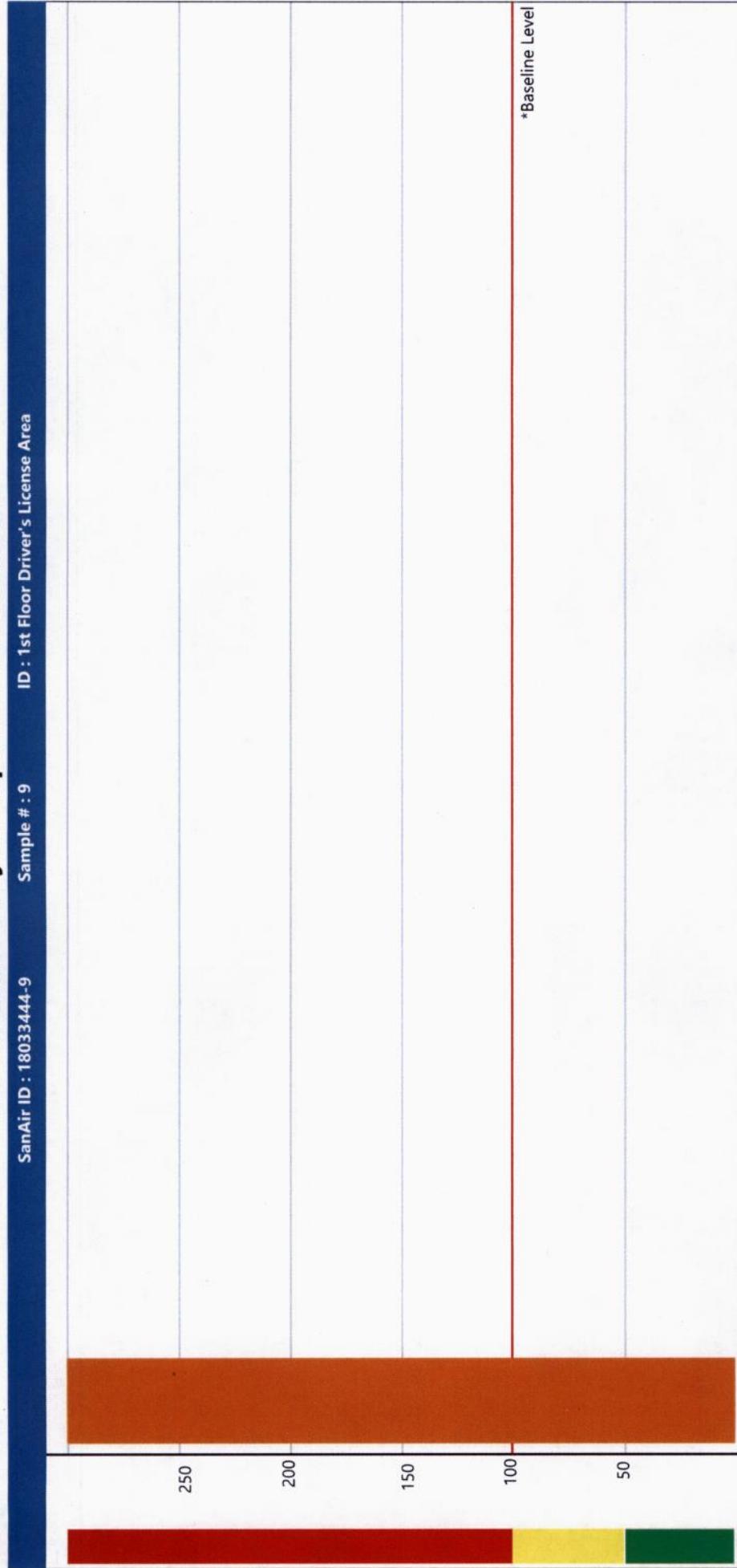
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Air Cassette Analysis - Spores % of Outside Air



A
>999%

Count/m³ higher than Baseline
Count/m³ comparable to Baseline
Within 50% of Baseline Count/m³

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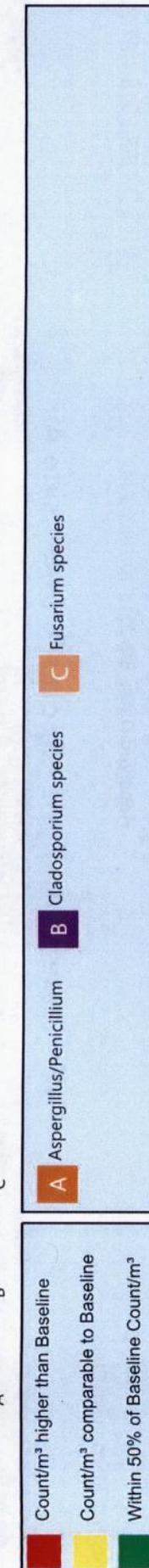
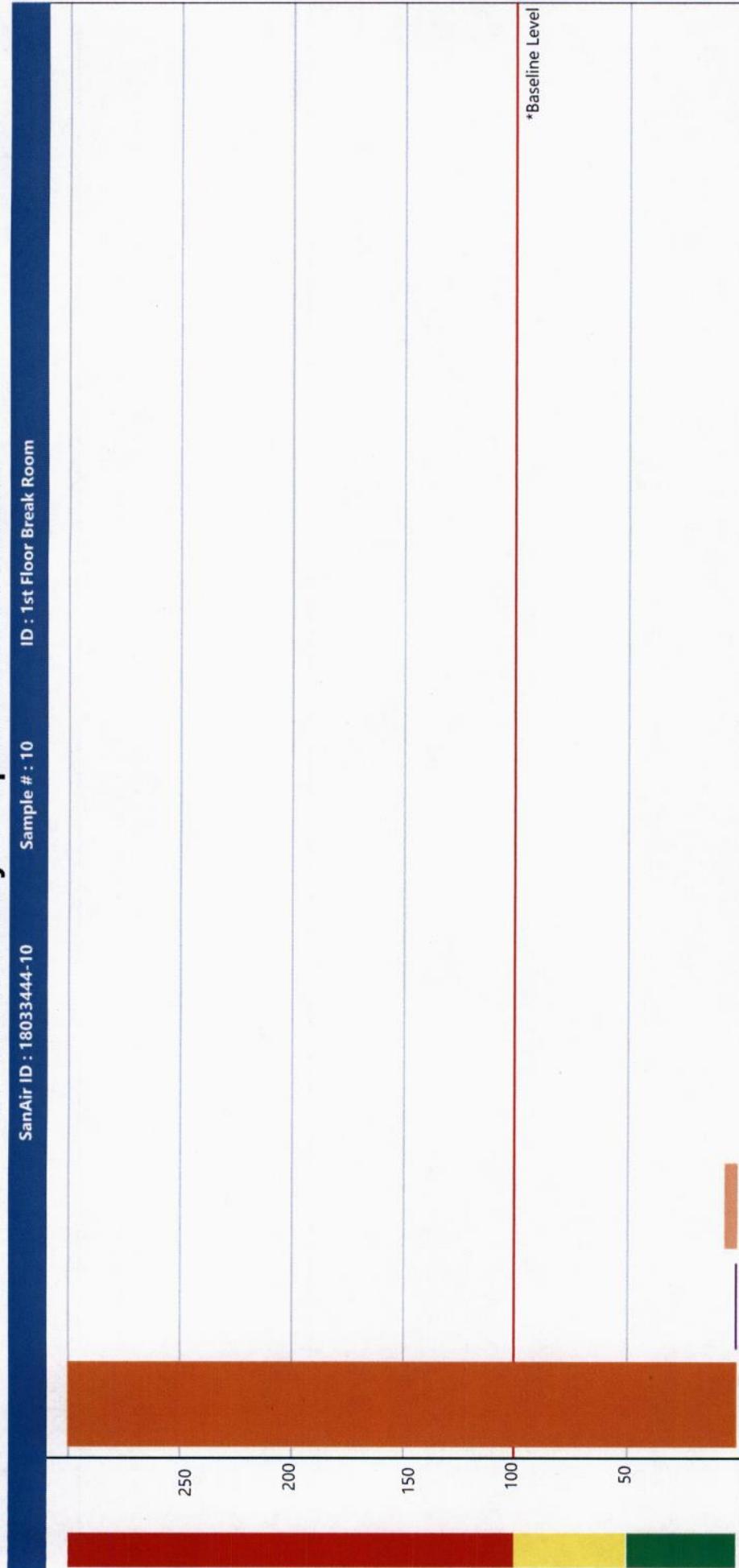
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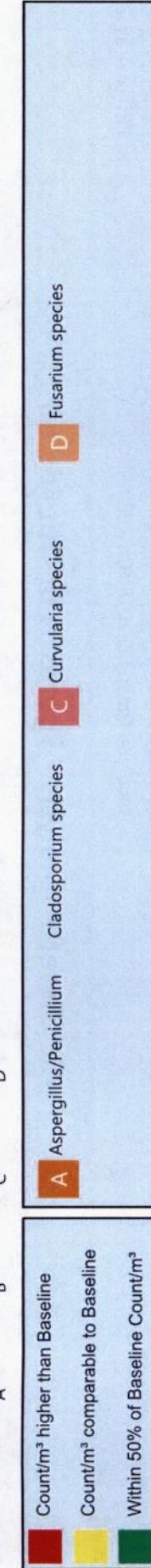
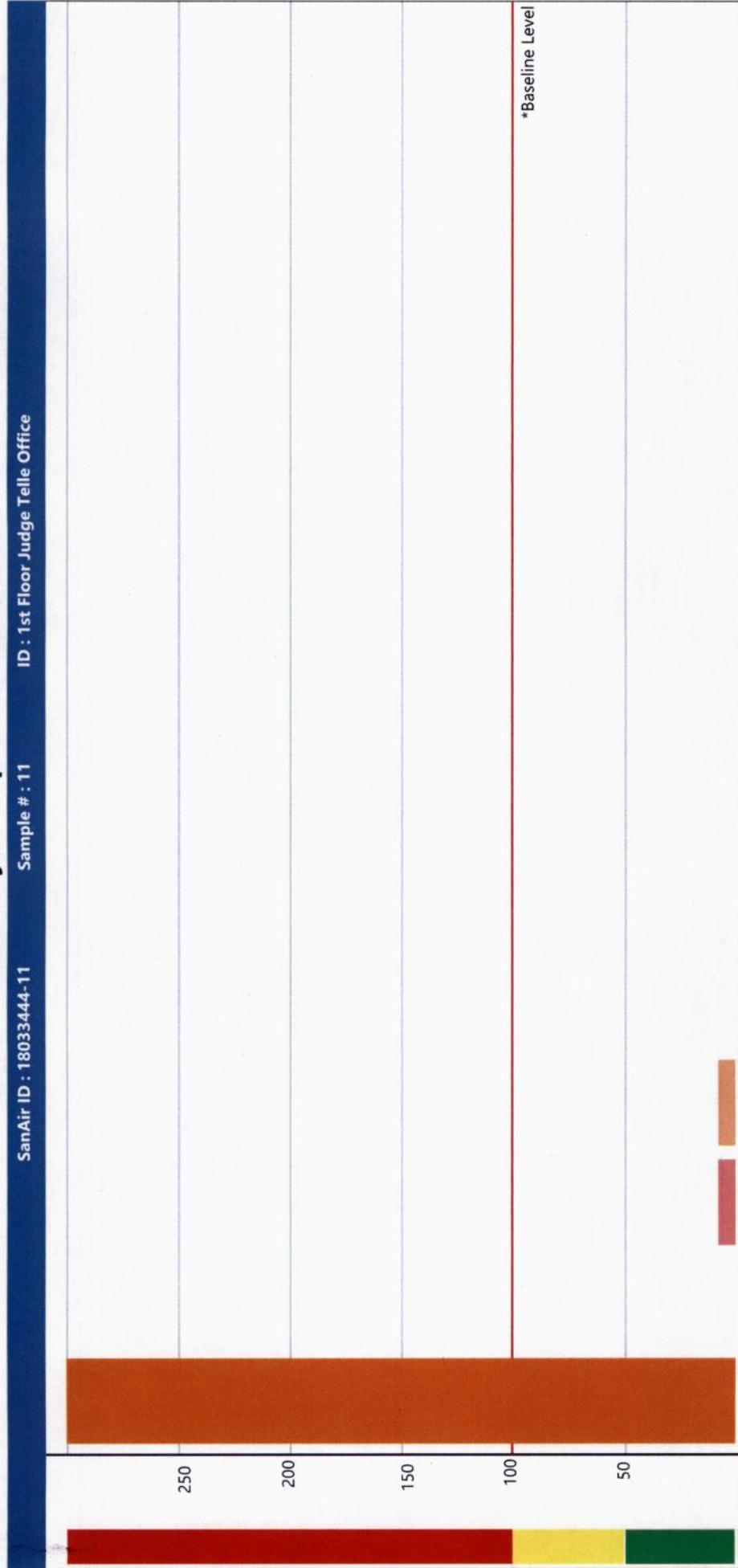
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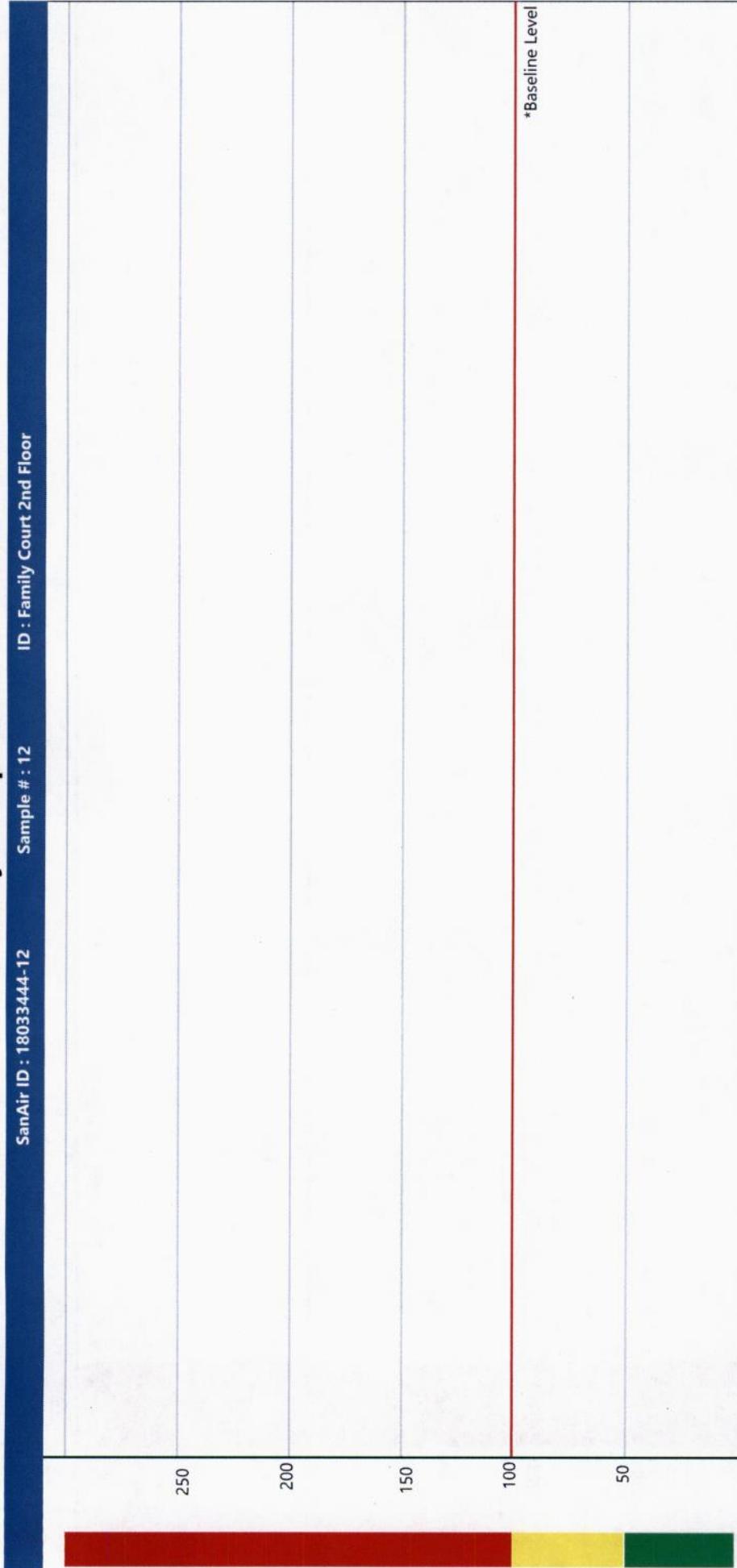
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Air Cassette Analysis - Spores % of Outside Air



- █ Count/m³ higher than Baseline
- █ Count/m³ comparable to Baseline
- █ Within 50% of Baseline Count/m³

*The Baseline Level (100%) represents the average baseline sample counts. Counts above the baseline may indicate higher than expected levels of a given result.

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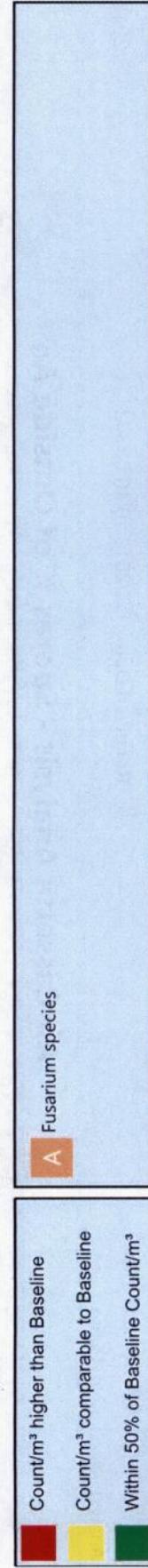
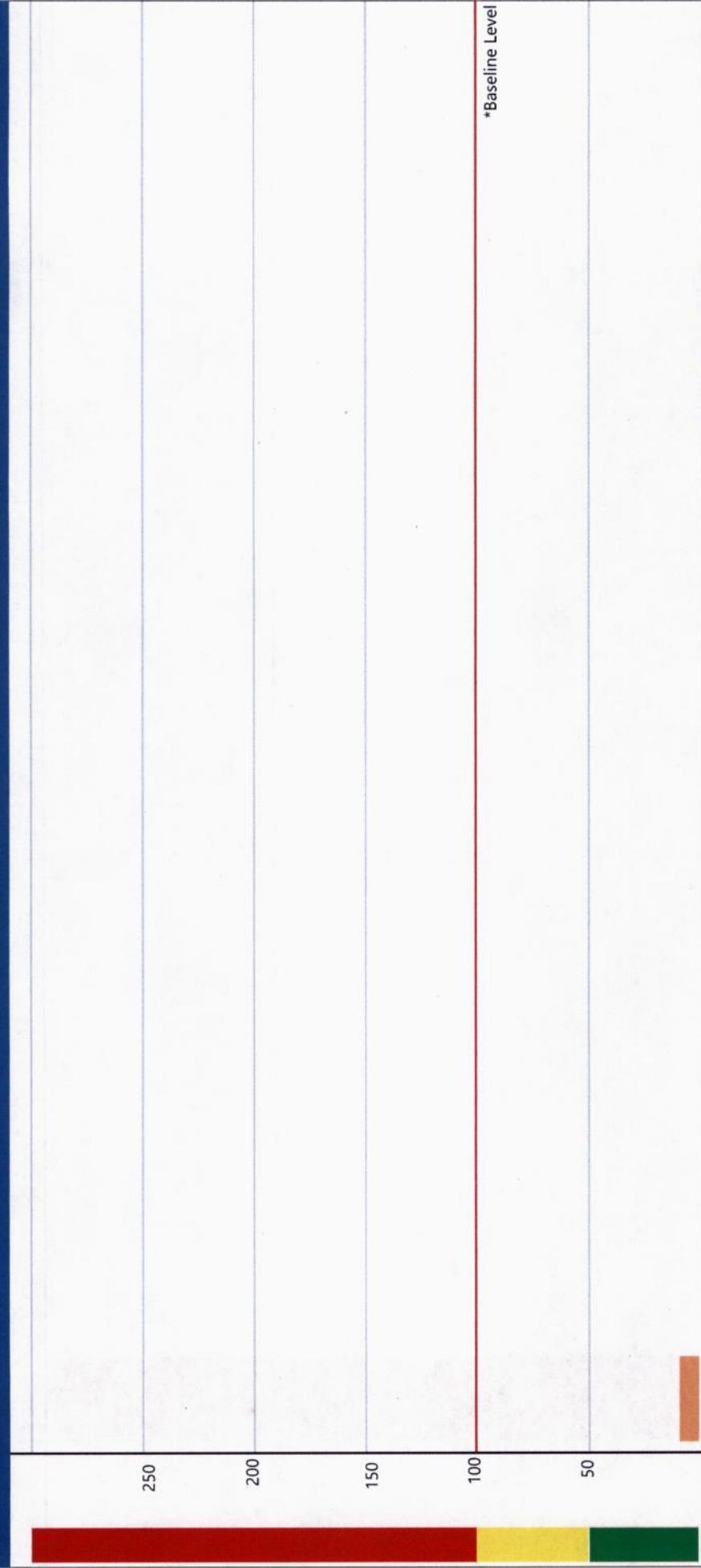
Project Number: 08184061
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Air Cassette Analysis - Spores % of Outside Air

SanAir ID : 18033444-13 Sample # : 13 ID : Circuit Judge Office



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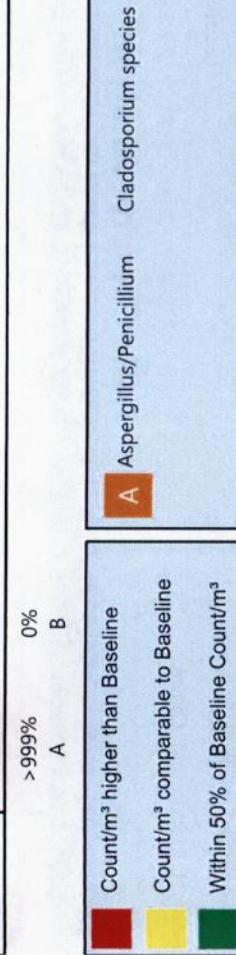
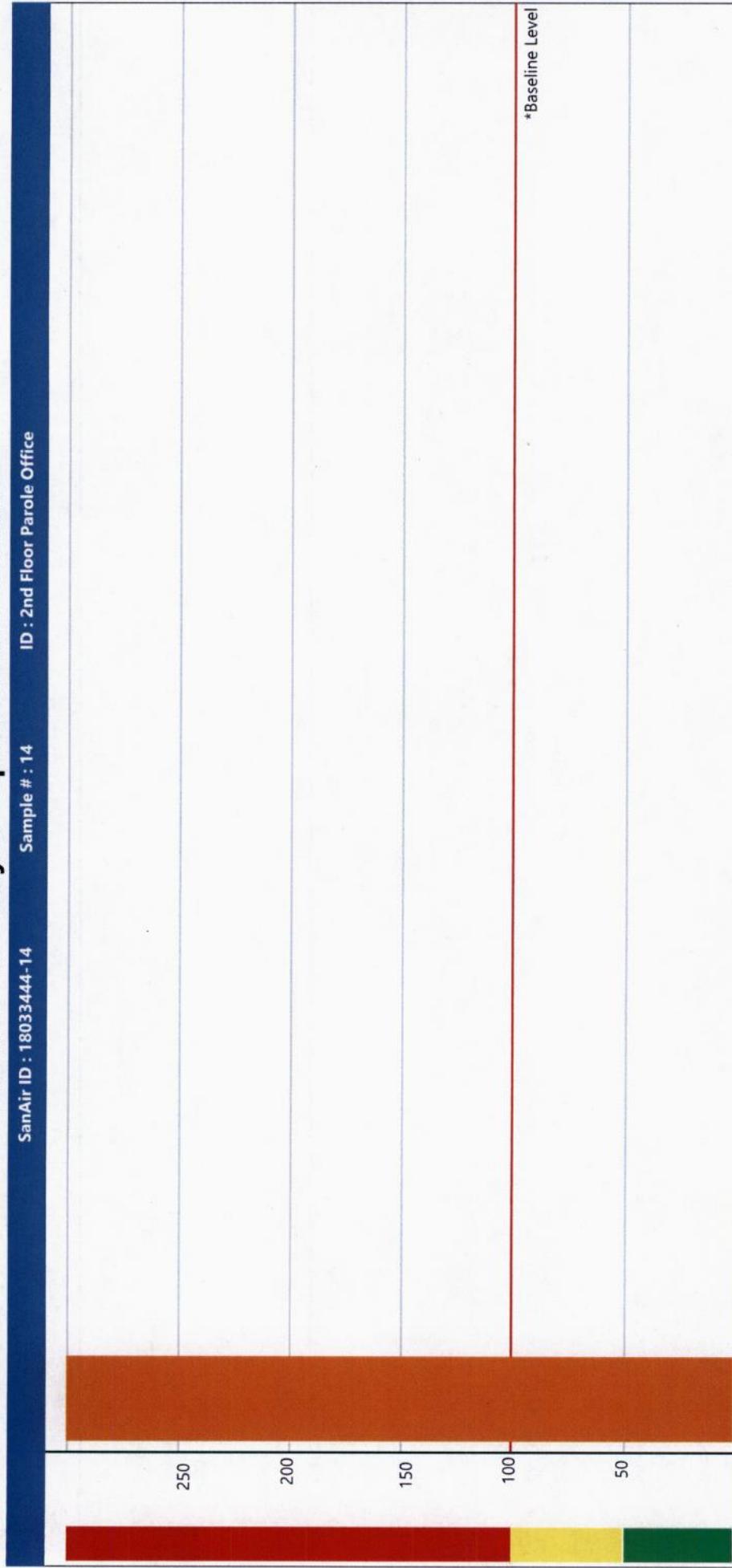
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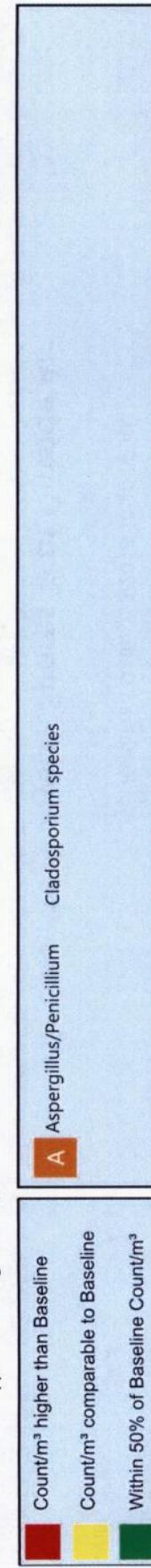
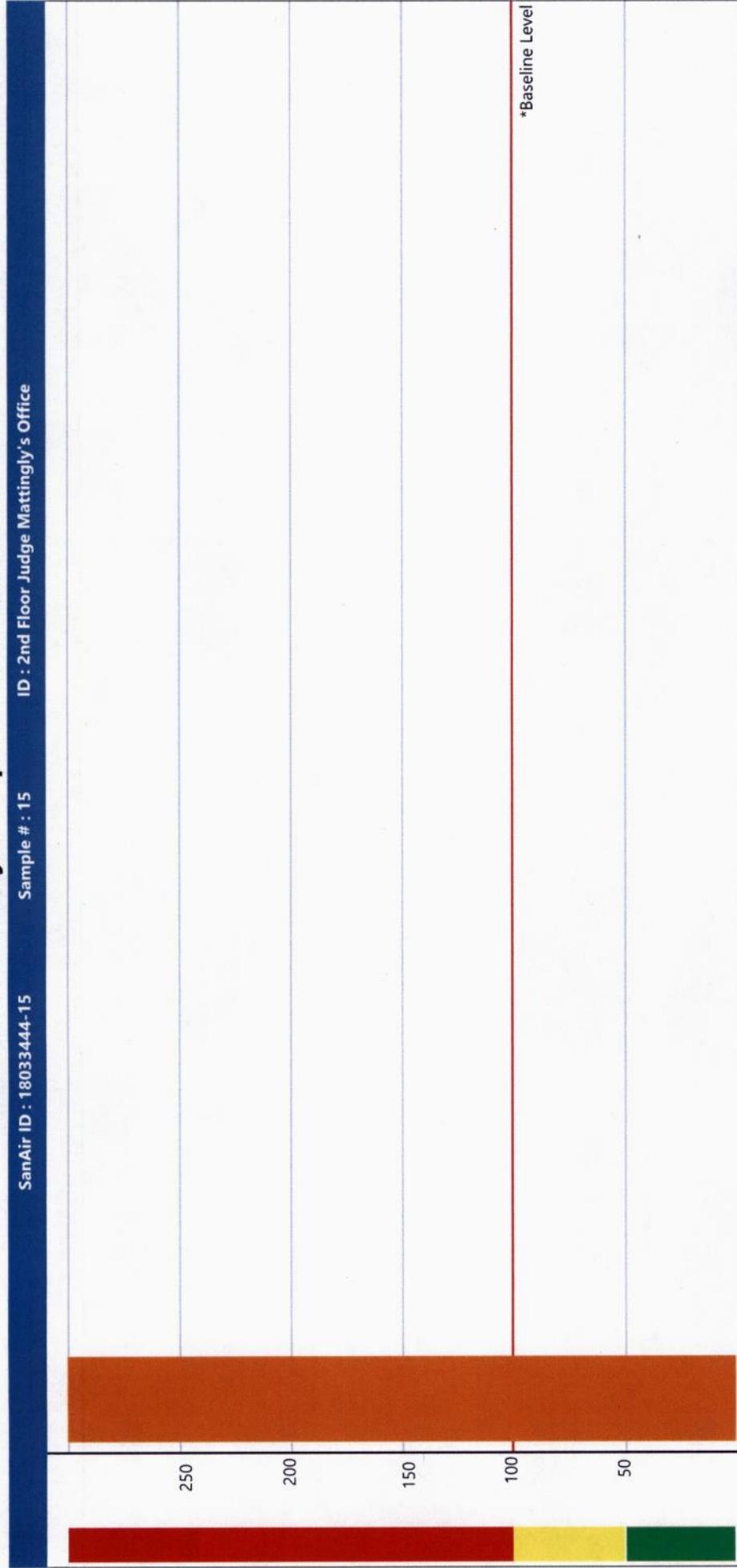


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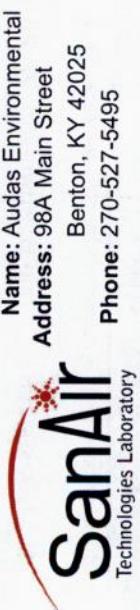
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Project Name:

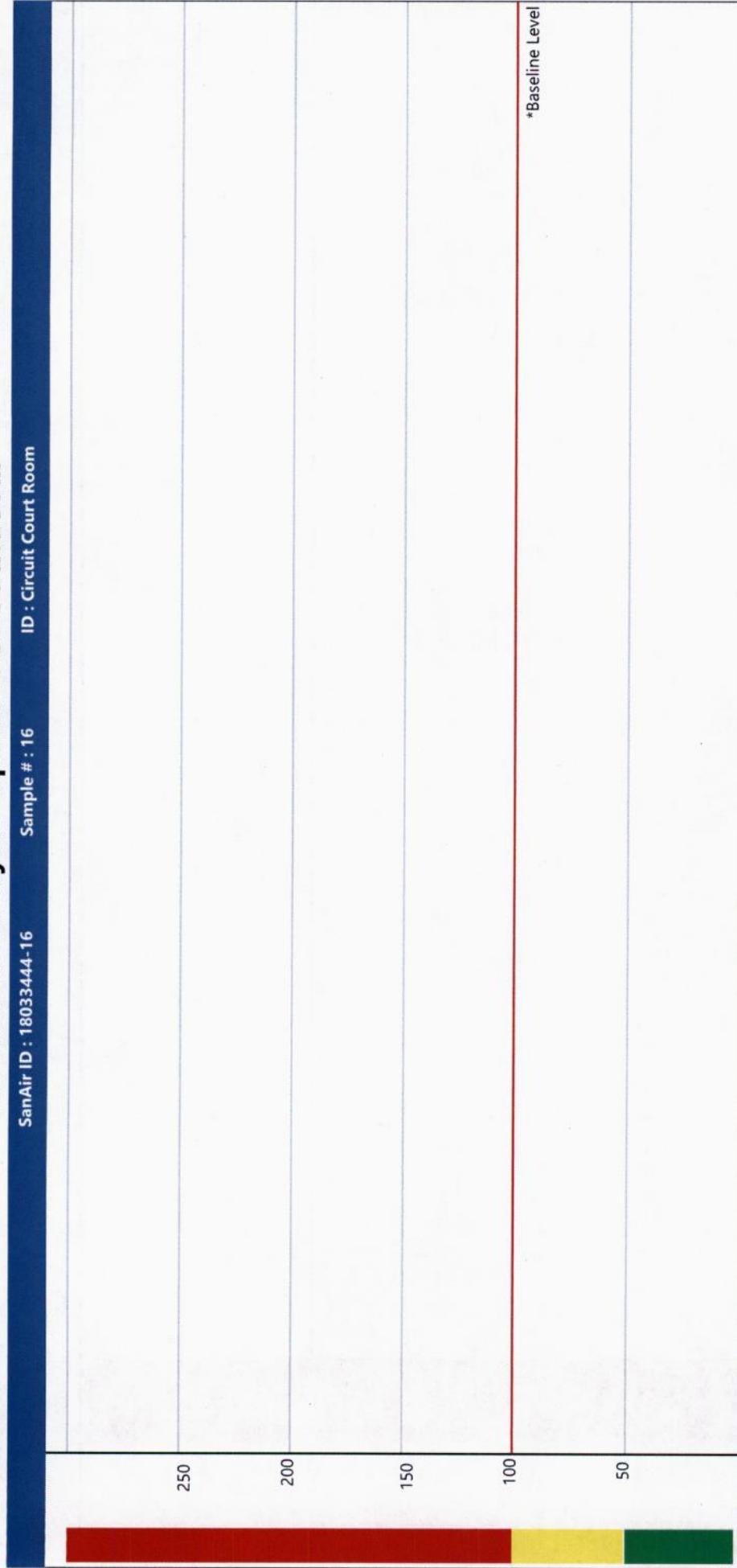
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Analyst: Macdonald, Claire

Air Cassette Analysis - Spores % of Outside Air



No organisms to graph. Normalized organism counts may not have exceeded the organism thresholds, or there were no organism counts for this sample. Please refer to the analysis report.

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Mycelial Fragments - A mycelium (plural = mycelia) is the "body" of a fungus. It is a collective term for hyphae (singular = hypha), which are the tubular units of the mycelium usually composed of chitin. The terms hyphae and mycelial fragments are used interchangeably. [This information was referenced from the mycology text "The Fifth Kingdom"] In some cases a fungal identification cannot be obtained due to lack of sporulation. Only the mycelial fragments are present, and cannot be identified without the distinguishing characteristics of the spores or the structures they grow from.

Health Effects: Allergic reactions may occur in the presence of spores (conidia) or mycelial/hyphal fragments.

Acremonium like - Found in plant decaying matter, plant debris, soils, and decaying organic matter.

Health Effects: Reported to be allergenic. Common type I and III allergen. It can produce mycetomas, infections of the nails, onychomycosis, corneal ulcers, eumycotic mycetoma, endophthalmitis, meningitis, and endocarditis.

Alternaria species - This genus compromises a large number of saprobes and plant pathogens. It is one of the predominate airborne fungal spores indoor and outdoor. Outdoors it may be isolated from samples of soil, seeds, and plants. It is one of the more common fungi found in nature, extremely widespread and ubiquitous. Conidia are easily carried by the wind, with peak concentrations in the summer and early fall. It is commonly found in outdoor samples. It is often found in indoor environments, on drywall, ceiling tiles, in house dust, carpets, textiles, and on horizontal surfaces in building interiors. Often found on window frames.

Health Effects: In humans, it is recognized to cause type I and III allergic responses. Because of the large size of the spores, it can be deposited in the nose, mouth and upper respiratory tract, causing nasal septum infections. It has been known to cause Baker's asthma, farmer's lung, and hay fever. It has been associated with hypersensitivity pneumonitis, sinusitis, deratormycosis, onychomycosis, subcutaneous phaeohyphomycosis, and invasive infection. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchospasms, chronic cases may develop pulmonary emphysema.

References: Flannigan, Brian, Robert A. Samson, and J. David Miller, eds. Microorganisms in Home and Indoor Work Environments: Diversity, Health Impacts, Investigation, and Control. London and New York: Taylor & Francis, 2001.

Ascospores - From the fungal Subphylum Ascomycotina. Ascospores are ubiquitous in nature and are commonly found in the outdoor environment. This class contains the "sac fungi" and yeasts. Some ascospores can be identified by spore morphology, however; some care should be exercised with regard to specific identification. They are identified on tape lifts and non-viable analysis by the fact that they have no attachment scars and are sometimes enclosed in sheaths with or without sacs. Ascomycetes may develop both sexual and asexual stages. Rain and high humidity may help ascii to release, and disperse ascospores, which is why during these weather conditions there is a great increase in counts.

Health Effects: This group contains possible allergens.

Aspergillus/Penicillium - These spores are easily aerosolized. Only through the visualization of reproductive structures can the genera be distinguished. Also included in this group are the spores of the genera Acremonium, Phialophora, Verticillium, Paecilomyces, etc. Small, round spores of this group lack the necessary distinguishing characteristics when seen on non-viable examination.

Health Effects: Can cause a variety of symptoms including allergic reactions. Most symptoms occur if the individual is immunocompromised in some way (HIV, cancer, etc). Both Penicillium and Aspergillus spores share similar morphology on non-viable analysis and therefore are lumped together into the same group.

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Basidiospores - From the Subphylum Basidiomycotina which contains the mushrooms, shelf fungi, and a variety of other macrofungi. They are saprophytes, ectomycorrhizal fungi or agents of wood rot, which may destroy the structure wood of buildings. It is extremely difficult to identify a specific genera of mushrooms by using standard culture plate techniques. Some basidiomycete spores can be identified by spore morphology; however, some care should be exercised with regard to specific identification. The release of basidiospores is dependant upon moisture, and they are dispersed by wind.

Health Effects: Many have the potential to produce a variety of toxins. Members of this group may trigger Type I and III fungal hypersensitivity reactions. Rarely reported as opportunistic pathogens.

Bipolaris/Drechslera - Found on grasses, grains, various plants, and decaying food. May grow in semi-dry environments. Some species are found in indoor environments. Because of the microscopic similarities between the two genera, they are grouped together on non-viable analyses.

Health Effects: Can occasionally cause corneal infection of the eye. This group of fungi constitutes the most commonly reported causes of allergic fungal sinusitis. They produce type I fungal hypersensitivity in humans.

References: St-Germain, Guy, and Richard Summerbell. Identifying Filamentous Fungi: A Clinical Laboratory Handbook. California: Star Publishing Co., 1996.

Cercospora species - Plant pathogen. Cercospora tends to grow on leaves. (Genera of Hyphomycetes, 1980)

References: J.W. Carmichael, W. Bryce Kendrick, I.L. Conners, Lynne Sigler Genera of Hyphomycetes University of Alberta Press, 1980

Chaetomium species - It is an ascomycete. It is found on a variety of substrates containing cellulose including paper and plant compost. It can be found on the damp or water damaged paper in sheetrock after a long term water damage. Several species have been reported to play a major role in decomposition of cellulose made materials. These fungi are able to dissolve the cellulose fibers in cotton and paper, and thus cause these materials to disintegrate. The process is especially rapid under moist conditions.

Health Effects: Chaetomium can produce type I fungal hypersensitivity and has caused onychomycosis (nail infections).

References: Flannigan, Brian, Robert A. Samson, and J. David Miller, eds. Microorganisms in Home and Indoor Work Environments: Diversity, Health Impacts, Investigation, and Control. London and New York: Taylor & Francis, 2001.

Cladosporium species - The most commonly identified outdoor fungus. The outdoor numbers are reduced in the winter and are often high in the summer. Often found indoors in numbers less than outdoor numbers. It is commonly found on the surface of fiberglass duct liner in the interior of supply ducts. A wide variety of plants are food sources for this fungus. It is found on dead plants, woody plants, food, straw, soil, paint and textiles. Often found in dirty refrigerators and especially in reservoirs where condensation is collected, on moist window frames it can easily be seen covering the whole painted area with a velvety olive green layer.

Health Effects: It is a common allergen. It can cause mycosis. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchospasms, chronic cases may develop pulmonary emphysema. Illnesses caused by this genus can include phaeohyphomycosis, chromoblastomycosis, hay fever and common allergies.

References: Flannigan, Brian, Robert A. Samson, and J. David Miller, eds. Microorganisms in Home and Indoor Work Environments: Diversity, Health Impacts, Investigation, and Control. London and New York: Taylor & Francis, 2001.

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Curvularia species - Curvularia is found on plant material and is considered a saprobe. It has also been isolated from dust samples and from wallpaper.

Health Effects: It has been reported to cause type I hypersensitivity and to be a cause of allergic fungal sinusitis. It may cause corneal infections, mycetoma and infections in immune compromised hosts.

References: De Hoog, G.S., J. Guarro, J. Gene, and M.J. Figueras. Atlas of Clinical Fungi, 2nd Edition. The Netherlands: CBS, 2000.

Epicoccum species - It is found in plants, soil, grains, textiles, and paper products. Frequently isolated from air and occasionally occurs in house dust. Is a saprophyte and considered a weakly parasitic secondary invader of plants, moldy paper and textiles. Epicoccum is usually isolated with either Cladosporium species or Aureobasidium species.

Health Effects: A common allergen. It also has the potential to produce type I fungal hypersensitivity reactions.

References: Flannigan, Brian, Robert A. Samson, and J. David Miller, eds. Microorganisms in Home and Indoor Work Environments: Diversity, Health Impacts, Investigation, and Control. London and New York: Taylor & Francis, 2001.

Fusarium species - A common soil fungus and plant pathogen. Fusarium is frequently isolated from plants and grains. It is often found in humidifiers and requires wet conditions to grow.

Health Effects: A type I allergen. Frequently involved in eye, skin and nail infections. Fusarium is the most common cause of mycotic keratitis and has been isolated from patients with a variety of infections. Some species produce mycotoxin. Food safety issues are related to some species of this genus.

References: Flannigan, Brian, Robert A. Samson, and J. David Miller, eds. Microorganisms in Home and Indoor Work Environments: Diversity, Health Impacts, Investigation, and Control. London and New York: Taylor & Francis, 2001.

Nigrospora species - Has been isolated from air and soil samples. Usually found in plant material as a saprobe.

Health Effects: It has been associated with type I allergic responses. No reported cases of infection.

References: St-Germain, Guy and Richard Summerbell. Identifying Filamentous Fungi: A Clinical Laboratory Handbook. California: Star Publishing Company., 1996.

Pestalotia- / Pestalotiopsis-like - This group consists of several genera. Mostly plant pathogens.

Pithomyces species - Grows on dead grass in pastures and decaying plant material.

Health Effects: Causes facial eczema in ruminants.

References: St-Germain, Guy, and Richard Summerbell. Identifying Filamentous Fungi: A Clinical Laboratory Handbook. California: Star Publishing Co., 1996.

Polythrincium species - This fungus is often associated with leaves and other plant material. There are no reports of any clinical significance or allergenic properties.

References: Ellis, Martin B., Ellis, Pamela, Microfungi on Land Plants: An Identification Handbook. England, The Richmond Publishing Co. Ltd., 1997.

Pyricularia species - This fungus tends to grow on grasses.

References: J.W. Carmichael, W. Bryce Kendrick, I.L. Conners, Lynne Sigler Genera of Hyphomycetes University of Alberta Press, 1980



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Rusts - From the group Uredinales, called Rusts due to the color of the spores, which are known for causing disease in plants.

Smuts/Myxomycetes - Smuts and Myxomycetes are parasitic plant pathogens. They are typically grouped together due to their association with plants, the outdoors and because they share similar microscopic morphology.

Health Effects: Can produce type I fungal hypersensitivity reactions.

References: Martin, G.W., C.J. Alexopoulos, and M.L. Farr. *The Genera of Myxomycetes*. Iowa City, Iowa: University of Iowa Press, 1983.

Zygomycota species - This fungi is known as a plant pathogen.

References: Ellis, Martin B., Ellis, Pamela, *Microfungi on Land Plants: An Identification Handbook*. England, The Richmond Publishing Co. Ltd., 1997.

Additional Information

Air Cassette Analyses

Air cassette reports indicate the genus and concentration of viable (living) and non-viable mold spores detected on the slide (A2 Analysis). Whether or not these spores are viable cannot be determined using this type of analysis. However, keep in mind that spores can remain allergenic even after cellular death. Other possible allergens include dander, pollen and fibers which are included in air cassette reports for the A1 Analysis. A1 and A2 analyses are performed on several types of air cassettes. Light microscopy at a 400 to 1000x magnification is used for air cassette sample analysis. SanAir always analyzes 100% of the impacted slide.

Explanation of Background Densities

The background density of an air cassette aids in the overall interpretation of results as it indicates the level of background debris present (e.g. dander, pollen, fibers, insect parts, soot, fly ash, etc.). Excessive background debris may mask the presence of fungal spores thereby reducing the accuracy of the count. It may also serve as an alert that the volume of air pulled was too high or too low. The following table explains background densities.

Air Cassette Density	Amount of Particulate on Slide	Explanation
1	Insignificant	Should not skew any counts
1+	Low	Should not skew any counts
2	Low to Moderate	Should not skew any counts
2+	Moderate to High	May cause occlusion of small spores
3	High	May cause occlusion of small to medium spores
3+	Very High	Will cause occlusion of spores
4	Overloaded	Level of particulate too high to perform analysis

A Note About the Fungal Spores

In some instances certain groups of fungi cannot be identified due to a lack of distinguishing characteristics. These fungi will be categorized as "unknown spores" on the final report.

The genera *Aspergillus* and *Penicillium* are typically composed of small, round spores that are difficult to distinguish from each other; therefore, they are grouped into the category *Aspergillus / Penicillium*. Other fungi that produce spores of similar characteristics may also be placed into this category, including *Paecilomyces*, *Gliocladium*, and *Trichoderma*, among others.

Stachybotrys and *Memnoniella* spores are coated with a sticky "slime" layer that may inhibit aerosolization.

Any genus of fungi detected on an air cassette with a high raw count (i.e. exceeding 500 spores) may be estimated. Any estimate higher than 12,000 spores will be reported as >12,000.

Understanding the Air Cassette Report

Each sample has 3 columns of information provided. The left is the raw count which is the number of spores for that fungal type detected on the trace. The middle column is the count per cubic meter (Count/m³) which is the raw count converted based on the total volume pulled for that sample. It represents the number of spores that should be expected in a cubic meter of air from the location in question if the spores were distributed evenly throughout the air. This column is helpful for interpreting results when the samples were pulled at different total volumes. In other words, the raw count of a cassette pulled at 75 liters should not be compared to the raw count of a cassette pulled at 150 liters because there may be higher counts associated with the higher volume. By comparing the "Count/m³" columns the difference in volumes are accounted for.

The limit of detection is the lowest spore count detectable with reasonable certainty, and it is calculated this way using a raw count of one. Keep in mind there are 1,000 liters in a cubic meter.

$$1 \times (1,000 / \text{Total Volume in Liters})$$

How to calculate the count per cubic meter:

$$\text{Raw Count} \times (1,000 / \text{Total Volume in Liters})$$

The last column on the right shows the percentage for which each spore type comprised the total spore count.

Understanding the Air Cassette Graph (If included in the final report)

The graph is a visual representation of the baseline sample (usually the outdoor air sample) compared individually against each indoor sample. Each spore type found on the indoor sample is compared to what was found outdoors per cubic meter.

The graph shows the percentile representation of each indoor spore count derived by dividing the indoor Count/m³ by the outdoor Count/m³. If the percentage is below 50% of the outside count, then the bar is below 50 on the chart, which corresponds to "Within 50% of Baseline Count/m³." If the percentage is between 50 and 100%, then the bar on the chart will stop between 50 and 100, which corresponds to "Count/m³ comparable to Baseline." If the percentage is greater than 100%, then the bar will be above 100 on the chart, which corresponds to "Count/m³ higher than Baseline."

Each organism is given a threshold level for the Count/m³. If this threshold level is not met in an inside sample, then the organism will not be graphed on the chart. This is used to prevent the graph from showing every spore type that is commonly found outside and doesn't typically indicate a possible moisture problem inside. For example, most common outdoor spores (e.g. ascospores, basidiospores, and *Cladosporium*) have a threshold level of 100. Therefore, in order to show up on the chart, the inside Count/m³ must be above 100. On the other hand, fungi that may indicate water damage (e.g. *Stachybotrys*, *Ulocladium*, *Chaetomium*, *Memnoniella*, etc.) are given lower threshold levels. These fungi have a higher water activity value and therefore require more moisture to grow. *Stachybotrys* and *Chaetomium* have threshold values of 14 and 30, respectively, as even a low count of those types of spores may indicate an issue with excess moisture.

Keep in mind that this graph is to be used only as a tool in the inspection of a building. Visual examination and knowledge of water damage, past remediation, and weather conditions, among other elements, is essential in the decision regarding the indoor air quality of a building.

Assistance with Remediation Projects

more information pertaining to interpretation of results is available on our website www.sanair.com

For assistance in a remediation project you may consult the Institute of Inspection, Cleaning and Restoration Certification's (IICRC) S500 and S520 protocols. The S500 is a reference guide for water-damage restoration and the S520 pertains specifically to mold remediation. Other standards and guidelines regarding Indoor Air Quality that may assist in remediation projects:

AIHA (Recognition, Evaluation, and Control of Indoor Mold)

AIHA (The Facts About Mold)

NADCA (ACR 2006)

IESO (Standards of Practice for the Assessment of Indoor Air Quality)

EPA (Mold Remediation in Schools and Commercial Buildings)

New York City Department of Health and Mental Hygiene (Guidelines on Assessment and Remediation of Fungi in Indoor Environments)

Disclaimer

SanAir Technologies Laboratory does not make contamination corrections to reports based upon analysis of laboratory and/or field blanks.

This report is the sole property of the client named on the SanAir Technologies Laboratory chain-of-custody. Neither results nor reports will be discussed with or released to any third party without our client's written permission. The information provided in this report applies only to the samples submitted and is relevant only for the date, time and location of sampling. SanAir assumes no responsibility for the method of sample procurement. Evaluation reports are based solely on the sample(s) in the condition in which they arrived at the laboratory and on the information provided by the client on the COC. SanAir will not provide any opinion on the safety of a building as visual inspection and knowledge of water damage, past remediation and weather conditions during sampling, among other elements, is essential in this decision. All samples are disposed of after 90 days unless otherwise requested by the client. SanAir is accredited by AIHA-LAP, LLC in the EMLAP program. Refer to our accreditation certificate or www.aihaaccreditedlabs.org for an up to date list of the Fields of Testing for which we are accredited.

This report does not constitute endorsement by AIHA-LAP, LLC/NVLAP and/or any other U.S. governmental agencies; and may not be certified by every local, state and federal regulatory agency.



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804.897.1177 / 888.895.1177
Fax 804.897.0070
sanair.com

**Microbiology
Chain of Custody**

Form 68, Revision 4, 1/26/2016

SanAir ID Number

18033444

Company: Audas Environmental	Project Number: 08184061	Phone #: 270-527-5495
Address: 98A Main St / PO Box 1033	Project Name:	Phone #:
City, State, Zip: Benton, KY 42025	Date Collected: 8/1/18	Fax #: 270-527-5498
Samples Collected By: Jason Rylee	P.O. Number:	Email: ted.audas@audasenv.com
Account #: 3204		Email: audrey.myers@audasenv.com

Sample Types		Analysis Types	Turn Around Time
AC	Air Cassette	A1 - Identification and Enumeration of Fungal spores, plus total dander, fiber, and pollen count A2 - Identification and Enumeration of Fungal spores only	3/6/24/48 Hour 3/6/24/48 Hour
T	Tape	D1 - Direct Identification of Fungi	3/6/24/48 Hour
B	Bulk	D2 - Direct Identification of Mites, Insects, Pollen, etc.	3/6/24/48 Hour
S	Swab	D3 - Direct Identification and Enumeration of Fungi	3/6/24/48 Hour
AP	Air Plate	C1 - Culture Identification and Enumeration of Fungi only	5-10 Days
B	Bulk	C2 - Culture Identification and Enumeration of Bacteria only	2-4 Days
S	Swab	C3 - Culture Identification and Enumeration of Fungi and Bacteria	5-10 Days
D	Dust	C4 - Culture Identification and Enumeration of Thermophilic Bacteria with C2 or C3 analysis DA1 - Dust Mite Allergen Test	2-4 or 5-10 Days 3/6/24/48 Hour

SanAir offers Legionella testing and other specialized culture analyses. Please call for details, COC and pricing.

Sample #	Sample Identification	Sample Type	Analysis Type(s)	Turn Around Time	Flow Rate (Liters/min)	Total Volume (L) or Area (in ²)	Time Start – Stop
1	1st floor front door control sample	AC	A2	6	15/4	60	
2	Outside back	AC	A2	6	15/4	60	
3	Outside front	AC	A2	6	15/4	60	
4	Basement circuit clerk storage	AC	A2	6	15/4	60	
5	South hallway basement	AC	A2	6	15/4	60	
6	Large storage room basement by door	AC	A2	6	15/4	60	
7	Room behind County Attorney office 1st fl	AC	A2	6	15/4	60	
8	District court room	AC	A2	6	15/4	60	
9	1st floor driver's license area	AC	A2	6	15/4	60	
10	1st floor break room	AC	A2	6	15/4	60	
11	1st floor Judge Telle office	AC	A2	6	15/4	60	
12	Family court 2nd floor	AC	A2	6	15/4	60	
13	Circuit Judge office	AC	A2	6	15/4	60	

Special Instructions

Relinquished by	Date	Time	Received by	Date	Time
M Myers	8/2/18	10:58	MC	AUG 03 2018	10:10AM

Unless scheduled, the turn around time for all samples received after 3 pm Friday will begin at 8 am Monday morning.
Weekend or Holiday work must be scheduled ahead of time and is charged at 150% of the 3 hr TAT rate.

There is a minimum charge of \$100 for weekend work. SanAir covers Standard Overnight FedEx shipping. Shipments billed to SanAir with a faster shipping rate will result in additional charges.



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Powhatan, VA 23139
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Microbiology Chain of Custody

Form 68, Revision 4, 1/26/2016

SanAir ID Number

18033444

Company: Audas Environmental	Project Number: 08184061	Phone #: 270-527-5495
Address: 98A Main St / PO Box 1033	Project Name:	Phone #:
City, State, Zip: Benton, KY 42025	Date Collected: 8/1/18	Fax #: 270-527-5498
Samples Collected By: Jason Rylee	P.O. Number:	Email: ted.audas@audasenv.com
Account #: 3204		Email: audrey.myers@audasenv.com

Sample Types		Analysis Types	Turn Around Time
AC	Air Cassette	A1 - Identification and Enumeration of Fungal spores, plus total dander, fiber, and pollen count A2 - Identification and Enumeration of Fungal spores only	3/6/24/48 Hour 3/6/24/48 Hour
T	Tape	D1 - Direct Identification of Fungi	3/6/24/48 Hour
B	Bulk	D2 - Direct Identification of Mites, Insects, Pollen, etc.	3/6/24/48 Hour
S	Swab	D3 - Direct Identification and Enumeration of Fungi	3/6/24/48 Hour
AP	Air Plate	C1 - Culture Identification and Enumeration of Fungi only	5-10 Days
B	Bulk	C2 - Culture Identification and Enumeration of Bacteria only	2-4 Days
S	Swab	C3 - Culture Identification and Enumeration of Fungi and Bacteria	5-10 Days
D	Dust	C4 - Culture Identification and Enumeration of Thermophilic Bacteria with C2 or C3 analysis	2-4 or 5-10 Days
DA1 - Dust Mite Allergen Test			
3/6/24/48 Hour			
SanAir offers Legionella testing and other specialized culture analyses. Please call for details, COC and pricing.			

Sample #	Sample Identification	Sample Type	Analysis Type(s)	Turn Around Time	Flow Rate (Liters/min)	Total Volume (L) or Area (in ²)	Time Start – Stop
14	2nd floor parole office	AC	A2	6	15/4	60	
15	2nd floor Judge Mattingly's office	AC	A2	6	15/4	60	
16	Circuit court room	AC	A2	6	15/4	60	

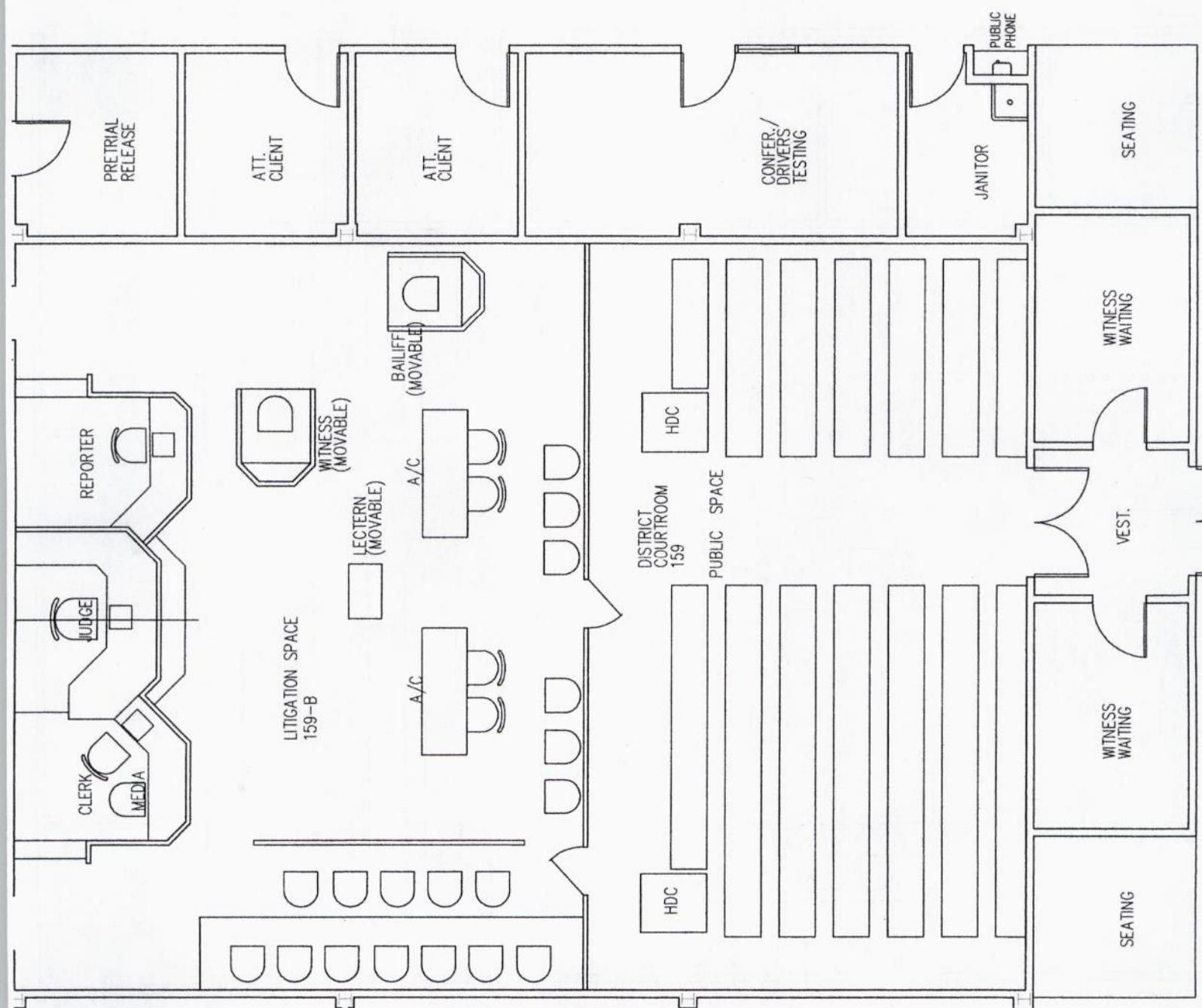
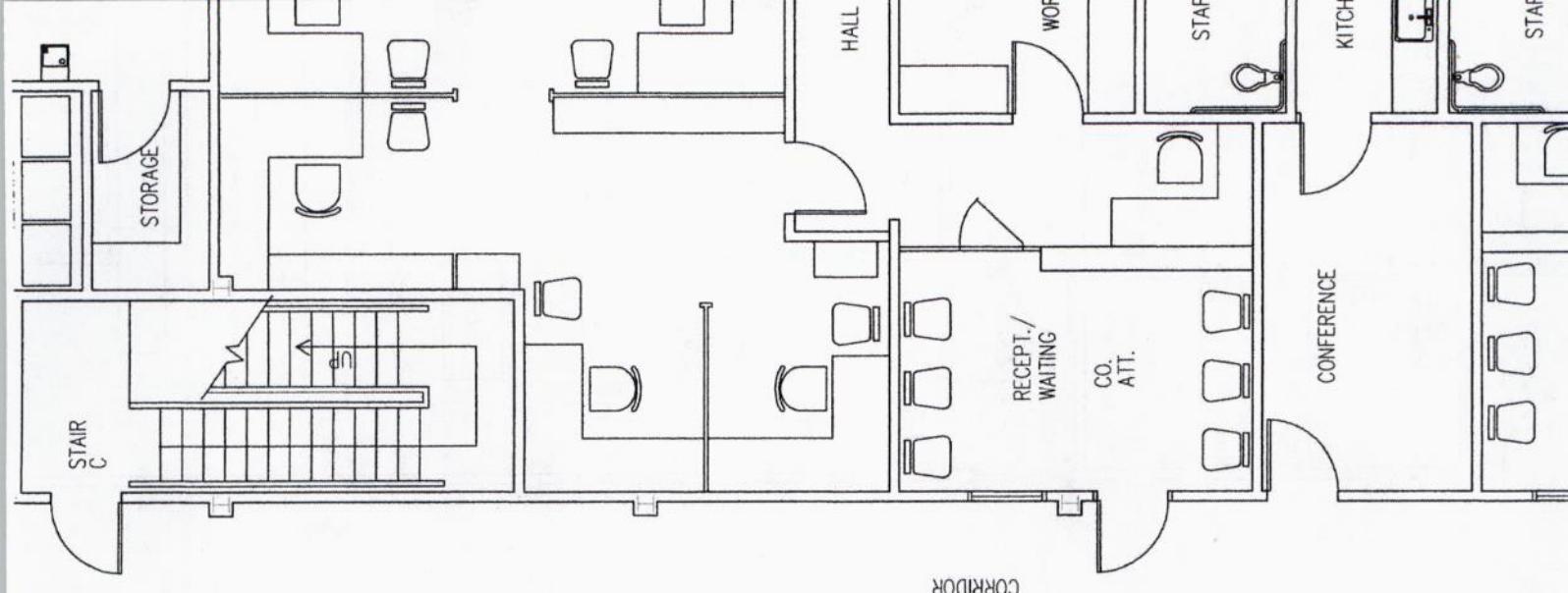
Special Instructions	
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Relinquished by	Date	Time	Received by	Date	Time
<i>Myers</i>	8/2/18	10:58	<i>MC</i>	AUG 03 2018	10:10 AM

Unless scheduled, the turn around time for all samples received after 3 pm Friday will begin at 8 am Monday morning.
Weekend or Holiday work must be scheduled ahead of time and is charged at 150% of the 3 hr TAT rate.

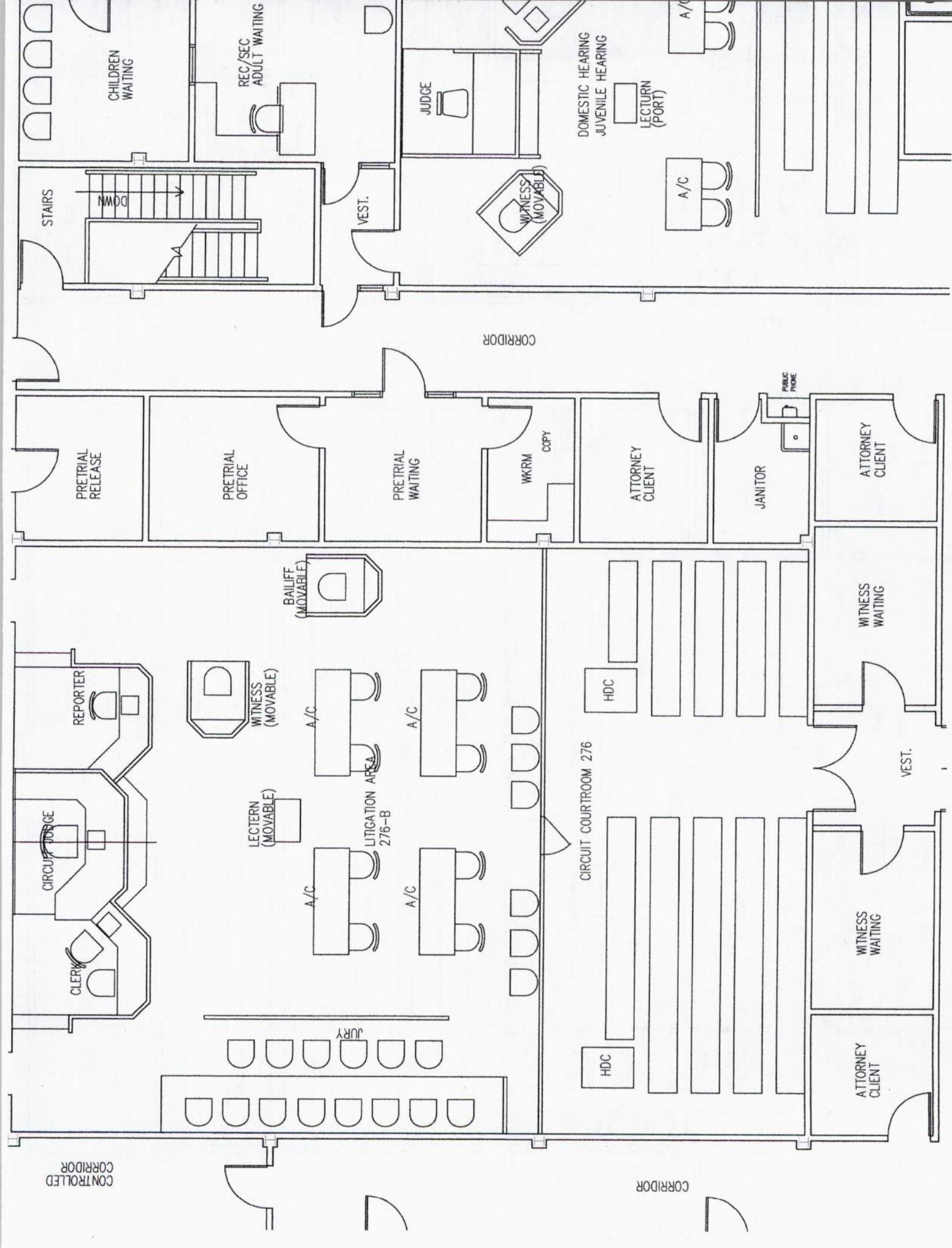
There is a minimum charge of \$100 for weekend work. SanAir covers Standard Overnight FedEx shipping. Shipments billed to SanAir with a faster shipping rate will result in additional charges.

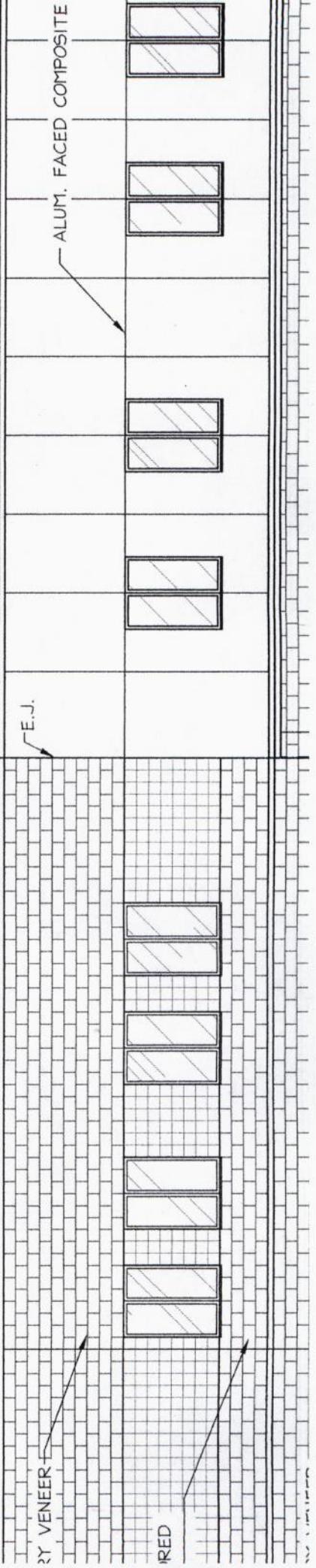
APPENDIX B: BUILDING FLOOR PLANS



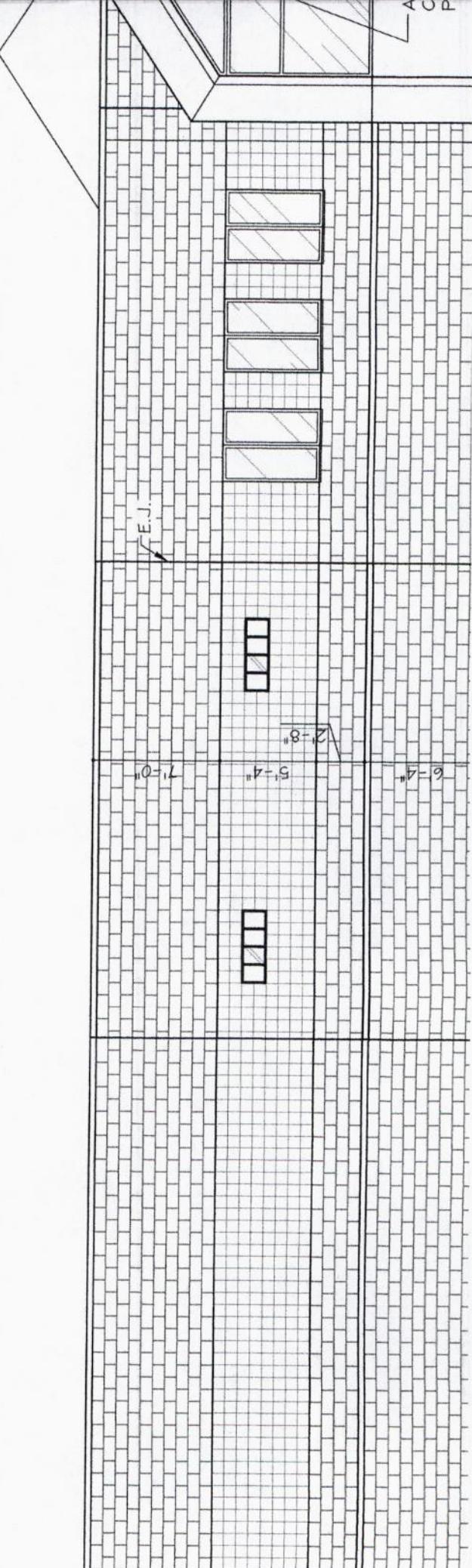
CORRIDOR

CORRIDOR





A
C
P



2'-8"

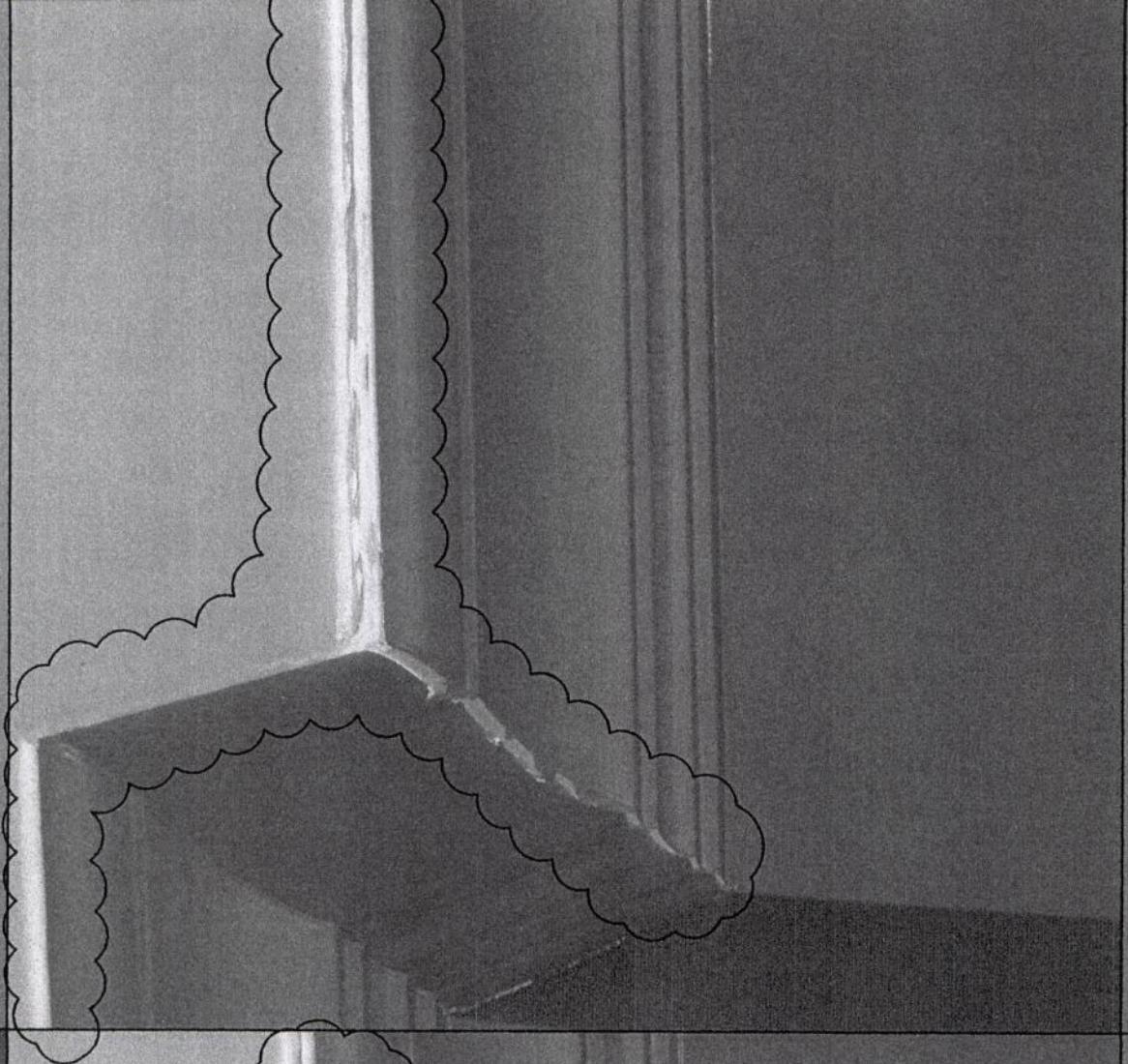
E.L.

5'-4"

7'-0"

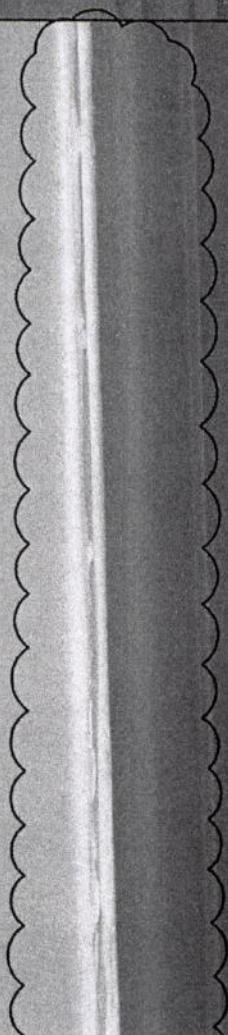
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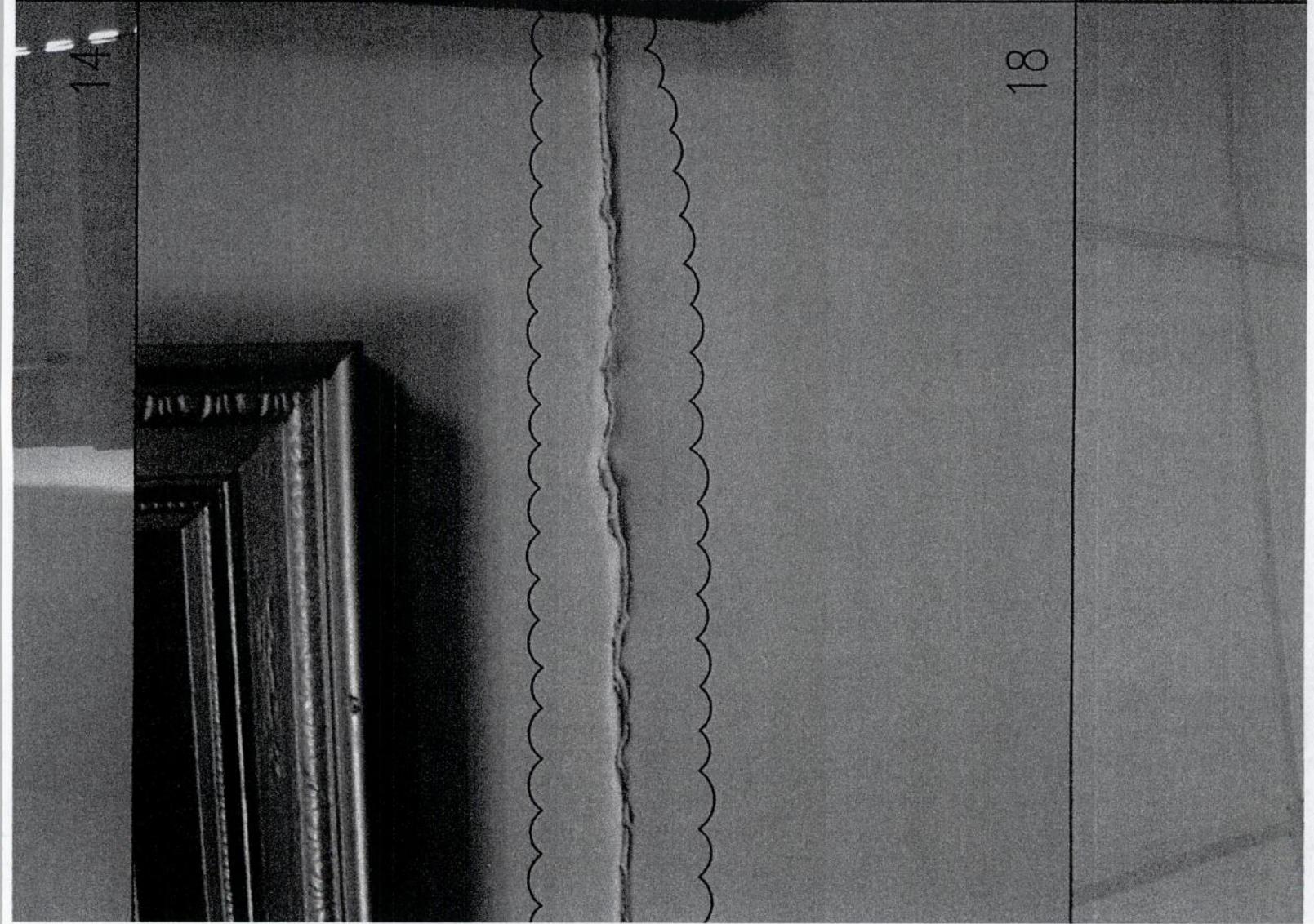
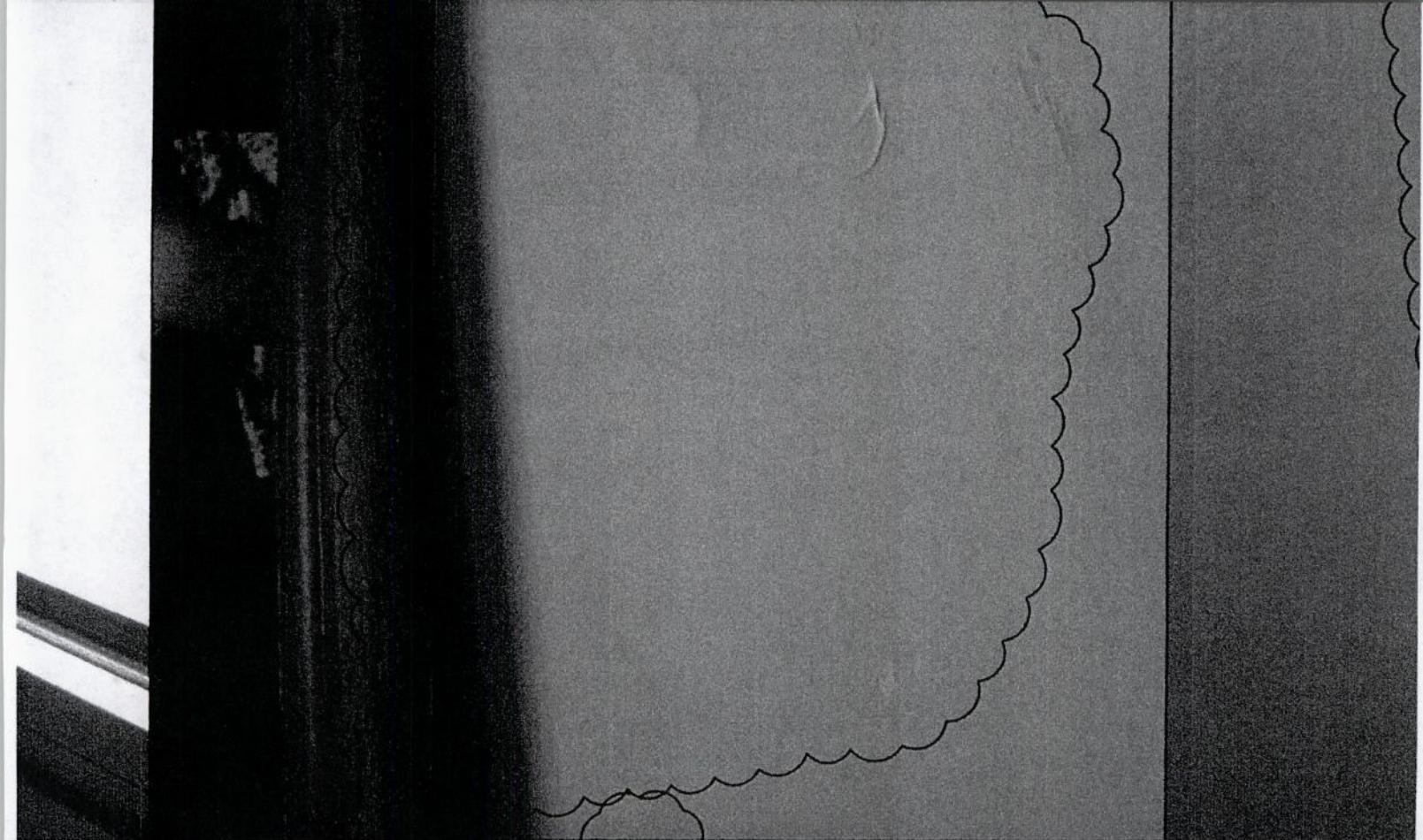
6'-4"



2

6

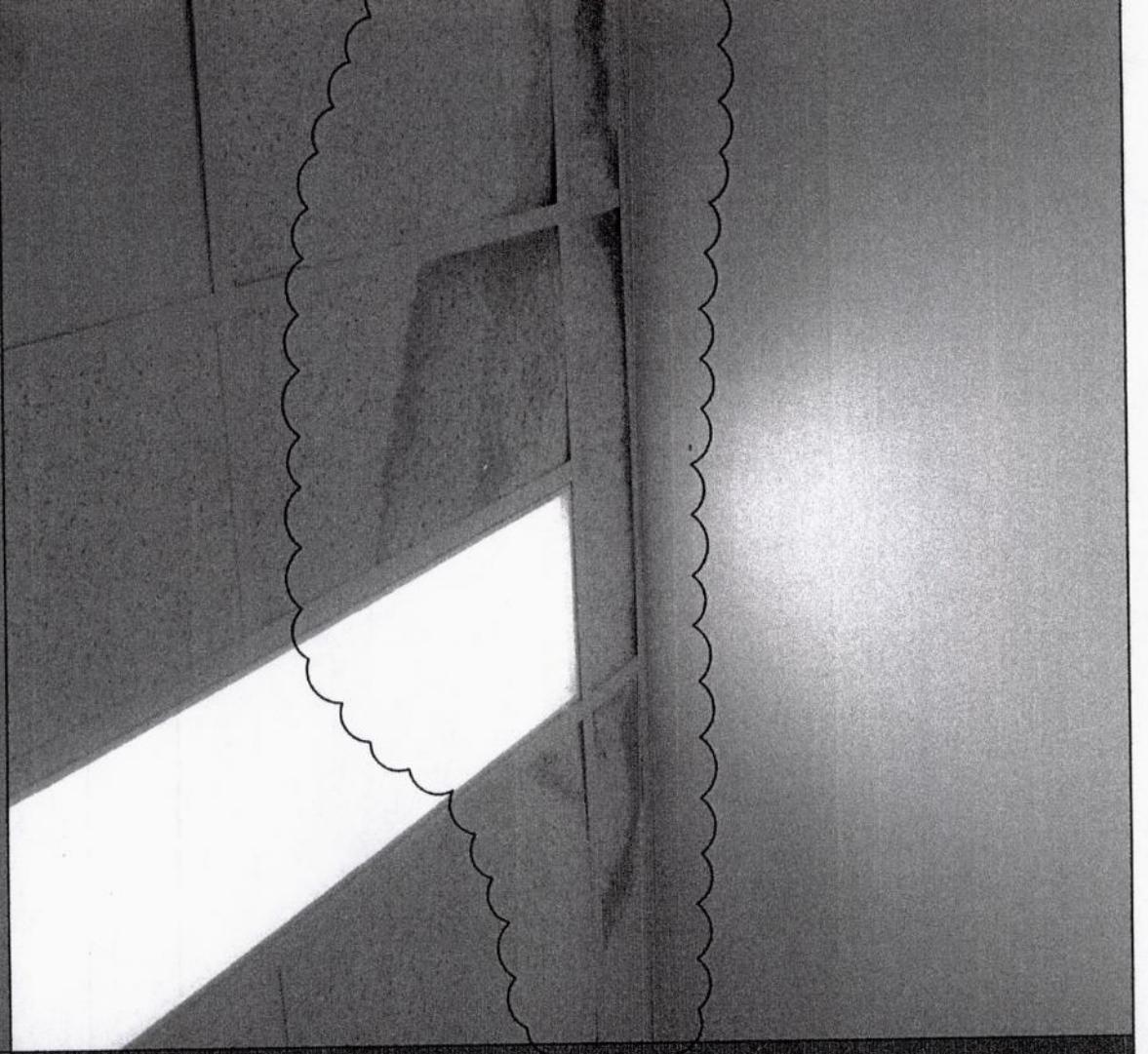




14

18

26



30



5. FURNISH WITH CONDENSATE CUT-OUT OVERFLOW SWITCH.
6. FURNISH EACH SYSTEM WITH A FILTER SECTION WITH ACCESS DOOR TO ACCEPT STANDARD SIZE FILTERS.
7. PROVIDE FULL SIZE RETURN AIR PLANUM, MIN. 12" LONG BEFORE REDUCING TO RA. DUCT SIZE.
8. CARRIER, TRANE, OR APPROVED EQUAL.

VENTILATING FAN SCHEDULE

SYMBOL	MANUFACTURER	MODEL/TYPE	SIZE	WATTS/AMPS	MOTOR HP	CFM	S.P. (INWC.)	SONES	MOUNTING
VF-1	GREENHECK	GB	24"	---	3/4	5000	615	0.25	ROOF

ACCESSORIES:

- A. GRAVITY BACKDRAFT DAMPER W/ DAMPER GUARD
- B. 14" HIGH PRE-FAB ROOF CURB. THE CURB SHALL BE CONSTRUCTED TO MATCH THE SLOPE THE ROOF AND PROVIDE A LEVEL SURFACE FOR MOUNTING OF EXHAUST FANS.
- C. THERMAL OVERLOAD
- D. BIRDSCREEN

BOILER SCHEDULE

SYMBOL	MANUFACTURER	MODEL	MBH INPUT	MBH OUTPUT	THERMAL EFFICIENCY	ELECTRICAL CHAR.
B-12	LOCHINVAR	CHN	750	630	84	15V/1φ

ACCESSORIES:

APPENDIX C: FINAL TEST AND BALANCE REPORT



Associated Air Balance Council

TEST AND BALANCE REPORT

PROJECT	MARSHALL COUNTY JUDICIAL FACILITY
ARCHITECT	CASTLEBERRY-MCGREGOR
ENGINEER	FARRIS,MCINTOSH,TREMPER, & ASS
TBI #	22493

THIS IS TO CERTIFY THAT THERMAL BALANCE INC. HAS BALANCED THE SYSTEM
HEREIN DESCRIBED IN ACCORDANCE WITH THE PLANS, SPECIFICATIONS, AND WITHIN
THE LIMITATIONS OF THE EQUIPMENT AND INSTALLATION. THE TESTING, BALANCING
AND ADJUSTING HAS BEEN PERFORMED IN ACCORDANCE WITH THE STANDARD
REQUIREMENTS AND PROCEDURES OF THE ASSOCIATED AIR BALANCE COUNCIL AND
THE RESULTS OF THESE TESTS ARE HEREIN RECORDED.

CERTIFICATION NO.

89-06-23

BY JAY A. JOHNSON

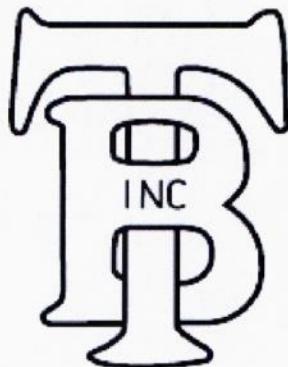
Nicholasville, KY 859.277.6158
Paducah, KY 270.744.9723Ashland, KY 606.325.4832
Nashville, TN 615.768.5461

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PAGE #	SHEET TYPE	SYSTEM	LOCATION
		AIR PROCEDURES	
		WATER PROCEDURES	
		ABBREVIATIONS	
1	Fan Test	HP'S	1ST FLR
2	Fan Test	HP'S	1ST FLR
3	Fan Test	HP'S	
4	Fan Test	HP'S	
5	Outlet Test	HP'S	
6	Outlet Test	HP'S	
7	Outlet Test		
8	Outlet Test	HP'S	
9	Outlet Test	HP'S	
10	Outlet Test	HP'S	
11	Outlet Test	HP'S	
12	Outlet Test	HP'S	
13	Fan Test	HP'S	SECOND FLR
14	Fan Test	HP'S	2ND FLR
15	Fan Test	HP'S	2ND FLR
16	Outlet Test	HP'S	
17	Outlet Test	HP'S	
18	Outlet Test	HP'S	
19	Outlet Test	HP'S	
20	Outlet Test	HP'S	
21	Outlet Test	HP'S	
22	Outlet Test	HP'S	
23	Outlet Test	HP'S	
24	Fan Test	HP'S	BASEMENT
25	Outlet Test	HP'S	
26	Fan Test	ERV	
27	Duct Traverse	ERV-1	ROOF
28	Duct Traverse	ERV-1 SUPPLY	ROOF
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32	Pump Data	CONDENSER WATER	MECH RM
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34	Flow Meter	CONDENSER WATER	
35	Flow Meter	CONDENSER WATER	
36	Flow Meter	CONDENSER WATER	

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THE AIR BALANCE FOR THIS PROJECT WAS ACCOMPLISHED BY THE FOLLOWING
BASIC PROCEDURE

AIR BALANCE PROCEDURE

1. Check all dampers on systems and secure in open position; fresh, return and exhaust dampers in required operating position.
2. Check air filters for cleanliness.
3. Check fan for proper rotation.
4. Check fan speed.
5. Check fan motor power reading.
6. Check system static pressure.
7. Establish total air on system by velocity traverse method.
8. Testing and adjust individual outlets for design CFM and adjust air flow pattern.

BALANCING INSTRUMENTS

Laser/Contact Tachometer

Clamp on Volt Ammeter

Digital vane Anemometer

Air Data Micromanometer/Flowhood

Portable Digital Thermometer

NOTE:(*)

ALL CFM READINGS ON OUTLET SHEETS WERE READ WITH A FLOW HOOD, UNLESS
OTHERWISE NOTED.

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THE WATER BALANCE FOR THIS PROJECT WAS ACCOMPLISHED BY THE FOLLOWING
BASIC PROCEDURE

GENERAL PROCEDURE

1. Develop a flow diagram, if one is not included in the design drawing.
2. By comparing pumps, primary heat exchanges and terminal units specified, determine if any diversity factor is intended.
3. Examine control diagrams to determine necessary adjustments of controls to obtain design flow conditions.
4. Inspect the system completely to insure that it has been flushed out and is clean, all manual valves are in the open or operating positions, all automatic valves are in their proper position, and operative, the expansion tanks are properly charged and the system is entirely void of air.
5. Utilizing the shop drawing and flow diagrams - starting from the pumps, list the required pressure drops of each component, including flow stations, CV of control valves, heat exchangers and coils. Design temperature drops should also be listed.

BALANCE PROCEDURE - PRIMARY AND SECONDARY CIRCUITS

1. Place the controls in positions of design flow.
2. Examine the flow diagram and piping for obvious short circuits. Check flow and balance these down.
3. Take suction, discharge and differential pressure readings at both full and no flow.
4. Take amp readings and volts and determine approximate brake horsepower.
5. Establish a pump curve and determine the approximate gallons being delivered.
6. If a total flow station exists, check the pressure differentials, determine the flow and compare with the pump curve flow.
7. If possible, set the total flow approximately 10% high.
8. If branch main flow stations exist, these should be tested and set; starting by setting the shortest runs low, as balancing proceeds to the longer branch runs.
9. Should the system incorporate primary secondary pumping circuits, it is essential that a reasonable balance be obtained in the primary loop before the secondary loop can be considered. However, it is imperative that the secondary pumps are running and terminal units open to flow when the primary loop is being balanced.

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Nashville, TN **615.768.5461**

Abbreviation Summary

AHU	AIR HANDLING UNIT
BHP	BRAKE HORSEPOWER
C.L.	CENTER LENGTH
CB	CIRCUIT BREAKER
CD	CEILING DIFFUSER
CW	CHILLED WATER
DD	DIRECT DRIVE
EAR	EXHAUST AIR REGISTER
EF	EXHAUST FAN
ER	EXHAUST REGISTER
ERU	ENERGY RECOVERY UNIT
ESP	EXTERNAL STATIC PRESSURE
F/O	FULLY OPEN
F/X	FIXED
FH	FUME HOOD
FLA	FULL LOAD AMPS
HW	HOT WATER
INA	INFORMATION NOT AVAILABLE
INACC	INACCESSIBLE
MAU	MAKE-UP AIR UNIT
MAX	MAXIMUM
MIN	MINIMUM
MTR	MOTOR
N/A	NOT APPLICABLE
N/D	NO DESIGN
N/I	NOT INSTALLED
N/L	NOT LISTED
N/R	NOT RUNNING
N/S	NOT SPECIFIED
N/W	NOT WIRED
NA	NOT ACCESSIBLE
O.D.	OUTSIDE DIAMETER
P.D.	PITCH DIAMETER
RAG	RETURN AIR GRILL
RG	RETURN GRILL
RR	RETURN REGISTER
S/F	SUPPLY FAN
SAG	SUPPLY AIR GRILL
SAR	SUPPLY AIR REGISTER
SF	SAFETY FACTOR
SLOT	SLOT DIFFUSER
SR	SUPPLY REGISTER
TP	THERMALLY PROTECTED
TSP	TOTAL STATIC PRESSURE
VFD	VARIABLE FREQUENCY DRIVE

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	1ST FLR



FAN TEST SHEET

FAN NO.	2) HP-144		6) HP-031		7) HP-012		8) HP-041	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	157-159		192		129-133		152	
MANUFACTURER	FHD		FHD		FHD		FHD	
MODEL NO.	EM144		EM031		EM012		EM041	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	4970	5384	940	885	350	377	960	993
RPM	N/L	1003/1006	H-M-L	HIGH	H-M-L	H	H-M-L	HIGH
HORSEPOWER	(2) 1½	(2) 1½	0.25	0.25	0.10	0.10	0.50	0.50
VOLTS PHASE	208-230/460	205/3	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	5.0/5.0/2.6	(A)	1.80	1.5	0.96	0.8	3.90	3.5
OUTLET CFM	4970	5384	940	885	360	377	960	993

FAN NO.	9) HP-024		10) HP-015		11) HP-018		12) HP-036	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	148-150		147-154		134-155		103	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM024		EM015		EM018		EM036	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	710	736	430	463	610	627	1210	1113
RPM	H-M-L	L	H-M-L	H	H-M-L	H	H-M-L	H
HORSEPOWER	0.25	0.25	0.10	0.10	0.25	0.25	0.50	0.50
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	1.80	1.10	0.96	0.8	1.80	1.3	3.90	3.10
OUTLET CFM	760	736	430	463	600	627	1210	1113

REMARKS:

A - 4.0/4.3/4.9; 4.0/3.8/3.5

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	1ST FLR



FAN TEST SHEET

FAN NO.	13) HP-007		14) HP-018		15) HP-018		16) HP-007	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	137		138-139		141/50		125-126	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM007		EM018		EM018		EM007	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	315	334	610	558	610	662	315	304
RPM	H-M-L	L	H-M-L	H	H-M-L	L	H-M-L	H
HORSEPOWER	0.10	0.10	0.25	0.25	0.25	0.25	0.10	0.10
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	0.96	0.85	1.80	1.4	1.80	1.2	0.96	0.89
OUTLET CFM	315	334	610	558	610	662	280	304

FAN NO.	20) HP-048		21) HP-018		22) HP-031		23) HP-048	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED			DRIVERS LICENSE					
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM048		EM018		EM031		EM048	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	1800	1748	610	658	940	901	1800	1771
RPM	H-M-L	H	H-M-L	H	H-M-L	M	H-M-L	H
HORSEPOWER	0.75	0.75	0.25	0.25	0.25	0.25	0.75	0.75
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	5.2	4.8	1.80	1.5	1.80	1.1	5.2	4.9
OUTLET CFM	1800	1748	615	658	940	901	1800	1771

REMARKS:

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Paducah, KY 270.744.9723



ThermalBalance.com

Ashland, KY 606.325.4832
Nashville, TN 615.768.5461





PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



FAN TEST SHEET

FAN NO.	24) HP-012		25) HP-012		26) HP-024		27) HP-007	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	106		115		111-118		119	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM012		EM012		EM024		EM007	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	350	384	350	374	710	717	315	325
RPM	H-M-L	H	H-M-L	H	H-M-L	M	H-M-L	H
HORSEPOWER	0.10	0.10	0.10	0.10	0.25	0.25	0.10	0.10
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	0.96	0.8	0.96	0.8	1.8	1.3	0.96	0.83
OUTLET CFM	350	384	350	374	680	717	315	325

FAN NO.	28) HP-007		29) HP-036		30) HP-024		31) HP-018	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	169/174-175		168		176-178		162-164	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM007		EM036		EM024		EM018	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	315	306	1210	1200	710	749	610	639
RPM	H-M-L	H	H-M-L	H	H-M-L	M	H-M-L	L
HORSEPOWER	0.10	0.10	0.50	0.50	0.25	0.25	0.25	0.25
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	0.96	0.80	3.90	3.2	1.8	1.3	1.8	1.2
OUTLET CFM	280	306	1210	1200	710	749	610	639

REMARKS:

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	



FAN TEST SHEET

FAN NO.	32) HP-024							
LOCATION	AFC							
AREA SERVED	183-186							
MANUFACTURER	FHP							
MODEL NO.	EM024							
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	710	728						
RPM	H-M-L	L						
HORSEPOWER	0.25	0.25						
VOLTS PHASE	1.80	1.1						
AMPS	700	728						
OUTLET CFM								

FAN NO.								
LOCATION								
AREA SERVED								
MANUFACTURER								
MODEL NO.								
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM								
RPM								
HORSEPOWER								
VOLTS PHASE								
AMPS								
OUTLET CFM								

REMARKS:

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST CFM	FINAL		RMK
						FPM	CFM		FPM	CFM	
2) HP-144											
	1	159	CD	8"0	1.0	/////////	200	163	/////////	220	
	2	159	CD	8"0	1.0	/////////	200	187	/////////	217	
	3	159	SAR	12"0	1.0	/////////	400	550	/////////	414	
	4	159	SAR	12"0	1.0	/////////	400	530	/////////	417	
	5	159A	CD	12"0	1.0	/////////	N/L	407	/////////	452	
	6	159A	CD	12"0	1.0	/////////	N/L	500	/////////	521	
	7	159A	CD	12"0	1.0	/////////	N/L	480	/////////	509	
	8	157	CD	6"0	1.0	/////////	100	99	/////////	110	
	9	159	SAR	12"0	1.0	/////////	400	570	/////////	408	
	10	159	SAR	12"0	1.0	/////////	400	580	/////////	422	
	11	159A	CD	12"0	1.0	/////////	N/L	470	/////////	502	
	12	159A	CD	12"0	1.0	/////////	N/L	500	/////////	540	
	13	159A	CD	12"0	1.0	/////////	N/L	491	/////////	543	
	14	158	CD	6"0	1.0	/////////	100	93	/////////	109	
6) HP-031											
	1	192	CD	12"0	1.0	/////////	470	446	/////////	446	
	2	192	CD	12"0	1.0	/////////	470	439	/////////	439	

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
7) HP-012											
	1	133	CD	6"0	1.0	/////////	60	47	/////////	66	
	2	132	CD	6"0	1.0	/////////	60	65	/////////	60	
	3	131	CD	6"0	1.0	/////////	60	55	/////////	65	
	4	130	CD	6"0	1.0	/////////	60	71	/////////	59	
	5	130	CD	6"0	1.0	/////////	60	63	/////////	61	
	6	129	CD	6"0	1.0	/////////	60	78	/////////	66	
8) HP-041											
	1	152	CD	8"0	1.0	/////////	240	230	/////////	230	
	2	152	CD	8"0	1.0	/////////	240	257	/////////	257	
	3	152	CD	8"0	1.0	/////////	240	256	/////////	256	
	4	152	CD	8"0	1.0	/////////	240	250	/////////	250	
9) HP-024											
	1	150	CD	10"0	1.0	/////////	350	404	/////////	340	
	2	148	CD	10"0	1.0	/////////	360	390	/////////	345	
	3	149	CD	6"0	1.0	/////////	50	111	/////////	51	

REMARKS:

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
10) HP-015											
	1	154	CD	8"0	1.0	/////////	200	172	/////////	210	
	2	153	CD	6"0	1.0	/////////	100	101	/////////	110	
	3	151	CD	6"0	1.0	/////////	80	107	/////////	88	
	4	147	CD	6"0	1.0	/////////	50	94	/////////	55	
11) HP-018											
	1	134	CD	8"0	1.0	/////////	200	195	/////////	215	
	2	155	CD	6"0	1.0	/////////	150	90	/////////	147	
	3	135	CD	6"0	1.0	/////////	100	89	/////////	110	
	4	143	CD	6"0	1.0	/////////	50	89	/////////	49	
	5	145	CD	6"0	1.0	/////////	50	95	/////////	52	
	6	136	CD	6"0	1.0	/////////	50	101	/////////	54	
12) HP-036											
	1	103	CD	10"0	1.0	/////////	305	275	/////////	275	
	2	103	CD	10"0	1.0	/////////	300	271	/////////	271	
	3	103	CD	10"0	1.0	/////////	300	289	/////////	289	
	4	103	CD	10"0	1.0	/////////	305	278	/////////	278	

REMARKS:

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
13) HP-007											
	1	137	CD	10"0	1.0	/////////	315	399	/////////	334	
14) HP-018											
	1	138	CD	8"0	1.0	/////////	200	184	/////////	184	
	2	139	CD	8"0	1.0	/////////	200	183	/////////	183	
	3	139	CD	8"0	1.0	/////////	210	191	/////////	191	
15) HP-018											
	1	141	CD	10"0	1.0	/////////	280	309	/////////	304	
	2	141	CD	10"0	1.0	/////////	280	339	/////////	309	
	3	50	CD	6"0	1.0	/////////	50	96	/////////	49	
16) HP-007											
	1	125	CD	12"0	1.0	/////////	140	174	/////////	151	
	2	126	CD	12"0	1.0	/////////	140	189	/////////	153	

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
20) HP-048											
	1	101	SAR	40 X 10	1.0	/////////	1800	1748	/////////	1748	
21) HP-018											
DRIVER'S LICENSE	1	NO #	CD	10"0	1.0	/////////	300	327	/////////	327	
DRIVER'S LICENSE	2	NO #	CD	10"0	1.0	/////////	315	331	/////////	331	
22) HP-031											
	1	104	CD	8"0	1.0	/////////	200	308	/////////	191	
	2	105	CD	10"0	1.0	/////////	240	338	/////////	234	
	3	104	CD	8"0	1.0	/////////	200	269	/////////	187	
	4	105	CD	10"0	1.0	/////////	240	127	/////////	230	
	5	107	CD	6"0	1.0	/////////	60	127	/////////	59	

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
23) HP-048											
	1	105	CD	10"0	1.0	//////////	250	0	//////////	230	
	2	105	CD	10"0	1.0	//////////	250	279	//////////	243	
	3	105	CD	10"0	1.0	//////////	250	310	//////////	260	
	4	105	CD	10"0	1.0	//////////	250	349	//////////	250	
	5	105	CD	10"0	1.0	//////////	250	298	//////////	270	
	6	105	CD	10"0	1.0	//////////	250	345	//////////	241	
	7	109	CD	10"0	1.0	//////////	300	220	//////////	277	
24) HP-012											
	1	106	CD	10"0	1.0	//////////	350	384	//////////	384	
25) HP-012											
	1	115	CD	10"0	1.0	//////////	350	374	//////////	374	

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		FPM	CFM	
26) HP-024											
	1	118	CD	10"0	1.0	/////////	250	276	/////////	275	
	2	116	CD	10"0	1.0	/////////	260	278	/////////	261	
	3	112	CD	6"0	1.0	/////////	50	82	/////////	55	
	4	114	CD	6"0	1.0	/////////	70	83	/////////	76	
	5	111	CD	6"0	1.0	/////////	50	87	/////////	50	
27) HP-007											
	1	119	CD	10"0	1.0	/////////	350	325	/////////	325	
28) HP-007											
	1	169	CD	8"0	1.0	/////////	180	162	/////////	197	
	2	174	CD	6"0	1.0	/////////	50	72	/////////	55	
	3	175	CD	6"0	1.0	/////////	50	86	/////////	54	
29) HP-036											
	1	168	SAR	78 X 8	1.0	/////////	1210	1200	/////////	1200	

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST CFM	FINAL		RMK
						FPM	CFM		FPM	CFM	
30) HP-024											
	1	178	CD	10"0	1.0	/////////	300	323	/////////	307	
	2	177	CD	8"0	1.0	/////////	180	199	/////////	198	
	3	177	CD	8"0	1.0	/////////	180	267	/////////	196	
	4	176	CD	6"0	1.0	/////////	50	87	/////////	48	
31) HP-018											
	1	162	CD	6"0	1.0	/////////	50	76	/////////	48	
	2	163	CD	6"0	1.0	/////////	50	62	/////////	54	
	3	164	CD	10"0	1.0	/////////	255	307	/////////	270	
	4	164	CD	10"0	1.0	/////////	255	353	/////////	267	
32) HP-024											
	1	183	CD	6"0	1.0	/////////	100	163	/////////	132	1
	2	184	CD	6"0	1.0	/////////	100	133	/////////	116	1
	3	185	CD	6"0	1.0	/////////	100	131	/////////	118	1
	4	186	CD	8"0	1.0	/////////	200	190	/////////	169	1
STAIR D	5	N/L	CD	8"0	1.0	/////////	200	236	/////////	193	

REMARKS:

1 - DAMPER INACC.

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	SECOND FLR



FAN TEST SHEET

FAN NO.	1) HP-144		33) HP-024		34) HP-024		35) HP-042	
LOCATION	MECH RM		AFC		AFC		AFC	
AREA SERVED	276		232-236/265		255-256/261-262		248-249/251-252	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM144		EM024		EM024		EM042	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	4970	4510	710	716	710	691	1260	1158
RPM	N/L	1012/1004	H-M-L	H	H-M-L	L	H-M-L	H
HORSEPOWER	(2) 1½	(2) 1½	0.25	0.25	0.25	0.25	0.50	0.50
VOLTS PHASE	208-230/460	205/3	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	5.0-5.0/2.5	(A)	1.80	1.5	1.80	1.1	3.90	2.5
OUTLET CFM	5000	4510	710	716	710	691	1215	1158

FAN NO.	36) HP-024		37) HP-042		38) HP-012		39) HP-024	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	258-260		253		274-275		239-241	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM024		EM042		EM012		EM024	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	710	741	1260	1269	350	299	710	690
RPM	H-M-L	H	H-M-L	H	H-M-L	L	H-M-L	H
HORSEPOWER	0.25	0.25	0.50	0.50	0.10	0.10	0.25	0.25
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	1.8	1.4	3.9	2.7	0.96	0.7	1.8	1.2
OUTLET CFM	680	741	1260	1269	280	299	710	690

REMARKS:

A - 3.3/3.4/3.6; 3.4/3.6/3.4

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	2ND FLR



FAN TEST SHEET

FAN NO.	40) HP-028		41) HP-007		42) HP-042		43) HP-015	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	242/246-247		228-229		208-205/213-215		205-207	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM028		EM007		EM042		EM015	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	940	926	315	307	1260	1038	430	435
RPM	H-M-L	H	H-M-L	H	H-M-L	M	H-M-L	H
HORSEPOWER	0.25	0.25	0.10	0.10	0.50	0.50	0.10	0.10
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	1.80	1.6	0.96	0.87	3.90	2.7	0.96	0.91
OUTLET CFM	940	926	280	307	960	1038	430	435

FAN NO.	44) HP-042		45) HP-036		46) HP-012		47) HP-036	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	201		203/210-211/217		218		220-224	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM042		EM036		EM012		EM036	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	1260	1366	1210	985	350	380	1210	1210
RPM	H-M-L	H	H-M-L	H	H-M-L	H	H-M-L	H
HORSEPOWER	0.50	0.50	0.50	0.50	0.10	0.10	0.50	0.50
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	3.90	2.7	3.90	2.9	0.96	0.83	3.90	2.9
OUTLET CFM	1260	1366	N/L	985	350	380	1210	1210
			+0.06"	-0.56"				

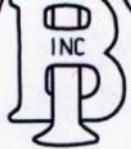
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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	2ND FLR



FAN TEST SHEET

FAN NO.	48) HP-018		49) HP-018		50) HP-024		51) HP-012	
LOCATION	AFC		AFC		AFC		AFC	
AREA SERVED	285-286		289-291		292/295-296		298	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM018		EM018		EM024		EM012	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	610	506	610	654	710	752	350	379
RPM	H-M-L	H	H-M-L	L	H-M-L	M	H-M-L	H
HORSEPOWER	0.25	0.25	0.25	0.25	0.25	0.25	0.10	0.10
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	1.80	1.5	1.80	1.3	1.80	1.6	0.96	0.87
OUTLET CFM	610	506	610	654	710	752	350	379

FAN NO.	52) HP-024		53) HP-024					
LOCATION	AFC		AFC					
AREA SERVED	278/279/281		267-270					
MANUFACTURER	FHP		FHP					
MODEL NO.	EM024		EM024					
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	710	746	710	775				
RPM	H-M-L	H	H-M-L	L				
HORSEPOWER	0.25	0.25	0.25	0.25				
VOLTS PHASE	208-230	205/1	208-230	205/1				
AMPS	1.8	1.6	1.8	1.3				
OUTLET CFM	710	746	700	775				

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		FPM	CFM	
1) HP-144											
CIRCUIT COURT	1	276	CD	8"0	1.0	//////////	200	136	//////////	181	
CIRCUIT COURT	2	276	CD	8"0	1.0	//////////	200	133	//////////	187	
CIRCUIT COURT	3	276	SAR	12"0	1.0	//////////	400	570	//////////	396	
CIRCUIT COURT	4	276	SAR	12"0	1.0	//////////	400	390	//////////	404	
CIRCUIT COURT	5	276	CD	12"0	1.0	//////////	500	276	//////////	356	1
CIRCUIT COURT	6	276	CD	12"0	1.0	//////////	500	290	//////////	388	1
CIRCUIT COURT	7	276	CD	12"0	1.0	//////////	500	303	//////////	372	1
CIRCUIT COURT	8	276	SAR	12"0	1.0	//////////	400	550	//////////	387	
CIRCUIT COURT	9	276	SAR	12"0	1.0	//////////	400	467	//////////	418	
CIRCUIT COURT	10	276	CD	12"0	1.0	//////////	500	364	//////////	463	
CIRCUIT COURT	11	276	CD	12"0	1.0	//////////	500	402	//////////	499	
CIRCUIT COURT	12	276	CD	12"0	1.0	//////////	500	364	//////////	459	
33) HP-024											
PRE-TRIAL RELEASE	1	265	CD	6"0	1.0	//////////	125	98	//////////	121	
PRE-TRIAL RELEASE	2	236	CD	8"0	1.0	//////////	170	249	//////////	183	
PRE WAITING	3	235	CD	6"0	1.0	//////////	150	103	//////////	140	
WKRM	4	234	CD	6"0	1.0	//////////	90	112	//////////	90	
ATT. CLT.	5	233	CD	6"0	1.0	//////////	125	101	//////////	130	
JANITOR	6	232	CD	6"0	1.0	//////////	50	128	//////////	52	

REMARKS:

1 - FULL OPEN

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
34) HP-024											
REC/SEC	1	235	CD	8"0	1.0	//////////	235	256	//////////	230	
CHILD WAIT	2	256	CD	8"0	1.0	//////////	225	275	//////////	218	
TLT	3	261	CD	6"0	1.0	//////////	50	112	//////////	52	
WKRM	4	262	CD	8"0	1.0	//////////	200	188	//////////	191	
35) HP-042											
SOCIAL WORK	1	252	CD	10"0	1.0	//////////	325	319	//////////	307	
LAW CLERK	2	251	CD	10"0	1.0	//////////	325	260	//////////	303	
COURT ADM.	3	249	CD	10"0	1.0	//////////	260	240	//////////	250	
COURT ADM.	4	249	CD	10"0	1.0	//////////	255	265	//////////	247	
TLT	5	248	CD	6"0	1.0	//////////	50	82	//////////	51	
36) HP-024											
CONFERENCE	1	258	CD	8"0	1.0	//////////	150	149	//////////	165	
FAMILY COURT	2	259	CD	8"0	1.0	//////////	165	203	//////////	180	
CONFERENCE	3	258	CD	8"0	1.0	//////////	150	161	//////////	162	
TLT	4	260	CD	6"0	1.0	//////////	50	103	//////////	53	
FAMILY COURT	5	259	CD	8"0	1.0	//////////	165	183	//////////	181	

REMARKS:

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
37) HP-042											
DOM. JUV. HEARING	1	253	CD	6"0	1.0	/////////	150	68	/////////	135	
DOM. JUV. HEARING	2	253	CD	10"0	1.0	/////////	225	232	/////////	227	
DOM. JUV. HEARING	3	253	CD	10"0	1.0	/////////	225	352	/////////	228	
DOM. JUV. HEARING	4	253	CD	10"0	1.0	/////////	330	313	/////////	340	
DOM. JUV. HEARING	5	253	CD	10"0	1.0	/////////	330	337	/////////	339	
38) HP-012											
WITNESS WAIT	1	275	CD	6"0	1.0	/////////	60	96	/////////	66	
WITNESS WAIT	2	275	CD	6"0	1.0	/////////	80	114	/////////	88	
WITNESS WAIT	3	274	CD	6"0	1.0	/////////	80	96	/////////	82	
WITNESS WAIT	4	274	CD	6"0	1.0	/////////	60	82	/////////	63	
39) HP-024											
ATT CLIENT	1	235	CD	6"0	1.0	/////////	150	111	/////////	137	
WITNESS	2	241	CD	8"0	1.0	/////////	250	236	/////////	245	
WITNESS	3	240	CD	8"0	1.0	/////////	250	256	/////////	247	
VEST.	4	238	CD	6"0	1.0	/////////	60	119	/////////	61	

REMARKS:

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
40) HP-028											
MEN	1	246	CD	6"0	1.0	/////////	50	76	/////////	52	
WOMEN	2	247	CD	6"0	1.0	/////////	50	80	/////////	48	
GRAND JURY	3	242	CD	12"0	1.0	/////////	420	412	/////////	425	
GRAND JURY	4	242	CD	12"0	1.0	/////////	420	355	/////////	401	
41) HP-007											
MEN	1	228	CD	12"0	1.0	/////////	140	201	/////////	153	
WOMEN	2	229	CD	12"0	1.0	/////////	140	124	/////////	154	
42) HP-042											
PP OFFICE	1	208	CD	8"0	1.0	/////////	200	271	/////////	220	
PP OFFICE	2	209	CD	8"0	1.0	/////////	200	254	/////////	215	
CDW OFFICE	3	213	CD	8"0	1.0	/////////	200	253	/////////	212	
CONFERENCE	4	214	CD	8"0	1.0	/////////	160	69	/////////	173	
JUV SERVICE	5	215	CD	8"0	1.0	/////////	200	275	/////////	218	

REMARKS:

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
43) HP-015											
WKRM	1	205	CD	6"0	1.0	/////////	100	61	/////////	95	
TLT	2	206	CD	6"0	1.0	/////////	50	76	/////////	55	
P/P OFFICE 3	3	207	CD	10"0	1.0	/////////	280	310	/////////	285	
44) HP-042											
LOBBY	1	201	CD	10"0	1.0	/////////	315	322	/////////	340	
LOBBY	2	201	CD	10"0	1.0	/////////	315	403	/////////	345	
LOBBY	3	201	CD	10"0	1.0	/////////	315	296	/////////	342	
LOBBY	4	201	CD	10"0	1.0	/////////	315	360	/////////	339	
45) HP-036											
REC/WAIT	1	217	CD	10"0	1.0	/////////	N/L	319	/////////	268	
WKRM	2	211	CD	8"0	1.0	/////////	160	265	/////////	167	
TLT	3	210	CD	6"0	1.0	/////////	50	79	/////////	51	
REC/WAIT PUR/PROB	4	203	CD	10"0	1.0	/////////	250	147	/////////	243	
REC/WAIT PUR/PROB	5	203	CD	10"0	1.0	/////////	250	218	/////////	256	
46) HP-012											
TELE. EQUIP.	1	218	CD	10"0	1.0	/////////	350	380	/////////	380	

REMARKS:

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
47) HP-036											
LAW LIBRARY	1	220	CD	10"0	1.0	//////////	250	247	//////////	261	
TLT	2	224	CD	6"0	1.0	//////////	50	76	//////////	53	
LAW LIBRARY	3	220	CD	10"0	1.0	//////////	250	236	//////////	247	
LAW LIBRARY	4	220	CD	10"0	1.0	//////////	250	210	//////////	226	
CUBICLE 3	5	221	CD	8"0	1.0	//////////	135	134	//////////	145	
CUBICLE 2	6	222	CD	8"0	1.0	//////////	135	130	//////////	138	
CUBICLE 1	7	223	CD	8"0	1.0	//////////	140	176	//////////	140	
48) HP-018											
CLERICAL WORK	1	285	CD	6"0	1.0	//////////	250	121	//////////	170	1
REC/WAIT	2	286	CD	8"0	1.0	//////////	180	279	//////////	173	
REC/WAIT	3	286	CD	8"0	1.0	//////////	180	261	//////////	163	
49) HP-018											
WORKROOM	1	290	CD	8"0	1.0	//////////	200	229	//////////	209	
TLT	2	291	CD	6"	1.0	//////////	50	122	//////////	55	
LAW CLERK	3	289	CD	10"0	1.0	//////////	360	434	//////////	390	

REMARKS:

1 - FULL OPEN 6"0 DUCT

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PROJECT NAME
SYSTEM
LOCATION

MARSHALL COUNTY JUDICIAL FACILITY
HP'S



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		CFM	FPM	
50) HP-024											
CONFERENCE	1	296	CD	8"0	1.0	////////	150	201	////////	160	
CONFERENCE	2	296	CD	8"0	1.0	////////	150	259	////////	150	
CIRCUS JUDGE	3	295	CD	8"0	1.0	////////	180	198	////////	190	
CIRCUS JUDGE	4	295	CD	8"0	1.0	////////	180	43	////////	197	
TOILET	5	292	CD	6"0	1.0	////////	50	138	////////	55	
51) HP-012											
ELEV. LOBBY	1	298	CD	12"0	1.0	////////	350	379	////////	379	
52) HP-024											
MEN	1	280	CD	6"0	1.0	////////	50	96	////////	49	
WOMEN	2	279	CD	6"0	1.0	////////	50	96	////////	47	
JURY DELIB.	3	281	CD	10"0	1.0	////////	305	279	////////	315	
JURY DELIB.	4	281	CD	10"0	1.0	////////	305	301	////////	335	

REMARKS:

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	HP'S
LOCATION	BASEMENT



FAN TEST SHEET

FAN NO.	4) HP-012		5) HP-012		17) HP-048		18) HP-012	
LOCATION	B-12		B-14		B-02		B-02	
AREA SERVED	B-12		B-14		102		B-03	
MANUFACTURER	FHP		FHP		FHP		FHP	
MODEL NO.	EM012		EM012		EM048		EM012	
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	280	308	280	307	1800	1918	280	301
RPM	H-M-L	L	H-M-L	L	H-M-L	L	H-M-L	M
HORSEPOWER	0.10	0.10	0.10	0.10	0.75	0.75	0.10	0.10
VOLTS PHASE	208-230	205/1	208-230	205/1	208-230	205/1	208-230	205/1
AMPS	0.96	0.7	0.96	0.7	5.2	4.7	0.96	0.8
OUTLET CFM	280	308	280	307	1800	1918	280	301

FAN NO.	19) HP-060							
LOCATION	B-01							
AREA SERVED	B-01							
MANUFACTURER	FHP							
MODEL NO.	EM060							
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	1875	1931						
RPM	H-M-L	H						
HORSEPOWER	0.75	0.75						
VOLTS PHASE	208-230	205/1						
AMPS	5.2	4.9						
OUTLET CFM	1875	1931						

REMARKS:

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

HP'S

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM		FPM	CFM	
4) HP-012											
	1	B-12	CD	10"0	1.0	/////////	280	349	/////////	308	
5) HP-012											
	1	B-14	CD	10"0	1.0	/////////	280	325	/////////	307	
17) HP-048											
SECURITY	1	102	SAR	12"0	1.0	/////////	450	424	/////////	456	
SECURITY	2	102	SAR	12"0	1.0	/////////	450	741	/////////	475	
SECURITY	3	102	SAR	12"0	1.0	/////////	450	680	/////////	492	
SECURITY	4	102	SAR	12"0	1.0	/////////	450	628	/////////	495	
18) HP-012											
	1	B-03	CD	10"0	1.0	/////////	280	325	/////////	301	
19) HP-060											
LOBBY	1	B-01	CD	10"0	1.0	/////////	325	234	/////////	316	
LOBBY	2	B-01	CD	8"0	1.0	/////////	200	189	/////////	218	
LOBBY	3	B-01	CD	10"0	1.0	/////////	325	345	/////////	338	
LOBBY	4	B-01	CD	10"0	1.0	/////////	325	359	/////////	330	
FUTURE	5	B-06	SAR	12"0	1.0	/////////	375	561	/////////	410	
LOBBY	6	B-01	CD	10"0	1.0	/////////	325	318	/////////	319	

REMARKS:

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	ERV
LOCATION	



FAN TEST SHEET

FAN NO.	ERV-1 SUPPLY		ERV-1 EXHAUST					
LOCATION	ROOF		ROOF					
AREA SERVED	(1)		(1)					
MANUFACTURER	GREENHECK		GREENHECK					
MODEL NO.	5225-B-ES		5225-B-ES					
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM	6800	5531	5700	4560				
RPM	1110	808	1038	1098				
HORSEPOWER	7.5	7.5	7.5	7.5				
VOLTS PHASE	208-230/460	218/3	208-230/460	218/3				
AMPS	(A)	13.4/14/13.2	(A)	(B)				
OUTLET CFM	5875	5217 (2)	4750	3732				

FAN NO.								
LOCATION								
AREA SERVED								
MANUFACTURER								
MODEL NO.								
	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL	DESIGN	FINAL
FAN CFM								
RPM								
HORSEPOWER								
VOLTS PHASE								
AMPS								
OUTLET CFM								

REMARKS:

- 1 - REFER TO OUTLET TEST SHEET
- 2 - TWO OUTLETS INACC. (NOT INCLUDED IN OUTLET TOTAL CFM)
- A - 21.4-19.6/9.8
- B - 10.4/11.5/12.2

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PROJECT NAME
SYSTEM
LOCATION

MARSHALL COUNTY JUDICIAL FACILITY
ERV-1
ROOF



DUCT TRAVERSE

REMARKS:

EXHAUST ZONE #1 - OUTLETS 23-36; ZONE #2 - OUTLETS 9-22; ZONE #3 - OUTLETS 1-8

TYPE: 1 - RECTANGLE 2 - CIRCLE 3 - FLAT OVAL

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	ERV-1 SUPPLY
LOCATION	ROOF



DUCT TRAVERSE

ZONE	DUCT SIZE (inches)	T Y P E	AREA (ft ²)	REQUIRED VELOCITY (fpm)	REQUIRED CFM	ACTUAL TEST VELOCITY (fpm)	ACTUAL TEST (cfm)	DUCT STATIC PRESSURE in W.G.	RMKS
34) HP-024	8	2	0.35	286	100	261	91	----	
35) HP-042	6	2	0.20	300	60	269	54	----	
36) HP-024	6	2	0.20	500	100	468	94	----	
37) HP-042	10	2	0.55	546	300	545	300	----	
38) HP-012	6	2	0.20	400	80	365	73	----	
40) HP-028	8	2	0.35	429	150	419	147	----	
39) HP-024	6	2	0.20	200	40	218	44	----	
53) HP-024	6	2	0.20	500	100	(1)	(1)	----	
52) HP-024	6	2	0.20	500	100	501	100	----	
49) HP-018	6	2	0.20	250	50	350	70	----	2
50) HP-024	6	2	0.20	500	100	453	91	----	
48) HP-018	6	2	0.20	250	50	231	46	----	
47) HP-036	8	2	0.35	429	150	455	159	----	
45) HP-036	6	2	0.20	250	50	235	47	----	
42) HP-042	8	2	0.35	514	180	502	176	----	
43) HP-015	6	2	0.20	250	50	110	22	----	3
3) HP-144	10 X 16	1	1.11	901	1000	915	1016	----	
31) HP-018	6	2	0.20	500	100	463	93	----	
32) HP-024	6	2	0.20	500	100	(1)	(1)	----	
30) HP-024	6	2	0.20	500	100	520	104	----	

REMARKS:

- 1 - INACC. (SOLID CEILING)
- 2 - NO DAMPER
- 3 - FULLY OPEN

TYPE: 1 - RECTANGLE 2 - CIRCLE 3 - FLAT OVAL

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PROJECT NAME
SYSTEM
LOCATION

MARSHALL COUNTY JUDICIAL FACILITY
ERV-1 SUPPLY
ROOF



DUCT TRAVERSE

REMARKS:

- 1 - FULLY OPEN**
2 - NOT INSTALLED
3 - NO DAMPER

TYPE: 1 - RECTANGLE 2 - CIRCLE 3 - FLAT OVAL

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	ERV-1
LOCATION	



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST	FINAL		RMK
						FPM	CFM	CFM	FPM	CFM	
EXHAUST											
	1	261	EG	6"0	1.0	/////////	100	123	/////////	90	
	2	260	EG	6"0	1.0	/////////	100	120	/////////	92	
	3	192	EG	18 X 12	1.0	/////////	550	430	/////////	430	
	4	182	EG	6"0	1.0	/////////	50	51	/////////	51	
	5	184	EG	6"0	1.0	/////////	100	86	/////////	86	
	6	185	EG	6"0	1.0	/////////	100	68	/////////	68	
	7	163	EG	6"0	1.0	/////////	100	59	/////////	59	
	8	162	EG	6"0	1.0	/////////	100	55	/////////	55	
	9	272	EG	6"0	1.0	/////////	50	100	/////////	100	1
	10	268	EG	6"0	1.0	/////////	100	134	/////////	134	1
	11	269	EG	6"0	1.0	/////////	100	126	/////////	126	1
	12	280	EG	6"0	1.0	/////////	100	98	/////////	93	
	13	279	EG	6"0	1.0	/////////	100	78	/////////	78	
	14	224	EG	6"0	1.0	/////////	100	50	/////////	50	
	15	112	EG	6"0	1.0	/////////	100	38	/////////	38	
	16	111	EG	6"0	1.0	/////////	100	36	/////////	36	
	17	210	EG	6"0	1.0	/////////	100	41	/////////	41	
	18	206	EG	6"0	1.0	/////////	100	32	/////////	32	

REMARKS:

1 - ABOVE SOLID CEILING, NO ACCESS, NO FACE DAMPER

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PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

ERV-1

LOCATION



OUTLET TEST REPORT

AREA SERVED	OUTLET NUMBER	ROOM NUMBER	OUTLET TYPE	OUTLET SIZE	AK	DESIGN		TEST CFM	FINAL		RMK
						FPM	CFM		FPM	CFM	
EXHAUST (CONT.)											
	19	291	EG	6"0	1.0	/////////	100	55	/////////	55	
	20	292	EG	6"0	1.0	/////////	100	49	/////////	49	
	21	176	EG	6"0	1.0	/////////	100	60	/////////	60	
	22	175	EG	6"0	1.0	/////////	100	38	/////////	38	
	23	232	EG	6"0	1.0	/////////	100	102	/////////	90	
	24	129	EG	6"0	1.0	/////////	100	92	/////////	92	
	25	147	EG	6"0	1.0	/////////	100	74	/////////	74	
	26	143	EG	6"0	1.0	/////////	100	70	/////////	70	
	27	142	EG	6"0	1.0	/////////	100	55	/////////	55	
	28	149	EG	6"0	1.0	/////////	100	68	/////////	68	
	29	126	EG	10"0	1.0	/////////	300	281	/////////	281	
	30	125	EG	10"0	1.0	/////////	300	231	/////////	231	
	31	246	EG	6"0	1.0	/////////	100	83	/////////	83	
	32	247	EG	6"0	1.0	/////////	100	88	/////////	88	
	33	248	EG	6"0	1.0	/////////	100	88	/////////	88	
	34	229	EG	10"0	1.0	/////////	300	347	/////////	276	
	35	228	EG	10"0	1.0	/////////	300	350	/////////	283	
	36	B-04	EG	6"0	1.0	/////////	100	92	/////////	92	

REMARKS:

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	CONDENSER WATER
LOCATION	MECH RM



PUMP DATA SHEET

PUMP NO.	P-3		
MANUFACTURER	B&G		
SIZE	SERIES 1510 3BC		
IMPELLER	9"		
SERVICE	CONDENSER WATER		

PUMP NO.	P-4		
MANUFACTURER	B&G		
SIZE	SERIES 1510 3BC		
IMPELLER	9"		
SERVICE	CONDENSER WATER		

TEST DATA	GPM	FT. HD.	BHP
DESIGN	450	65	
ACTUAL	450	65	
DISCHARGE			
SUCTION			
DELTA P		*2.307=	FT. HD.

TEST DATA	GPM	FT. HD.	BHP
DESIGN	450	65	
ACTUAL	450	65	
DISCHARGE			
SUCTION			
DELTA P		*2.307=	FT. HD.

BLOCK OFF	81 FT. HD.		
DISCHARGE			
SUCTION			
DELTA P	*2.307=		

BLOCK OFF	81 FT. HD.		
DISCHARGE			
SUCTION			
DELTA P	*2.307=		

MOTOR MFG	BALDOR		
HORSEPOWER	-----		
RPM	1760		
VOLTS	A	ACT.	208 / 3 /
AMPS	B	ACT.	29.7 / 27.8 / 25.0
OVERLOADS	GE F487B (37.7-41.9)		

MOTOR MFG	BALDOR		
HORSEPOWER	-----		
RPM	1760		
VOLTS	A	ACT.	208 / 3 /
AMPS	B	ACT.	25.3 / 28.3 / 30.0
OVERLOADS	GE 487B (37.7-41.9)		

REMARKS:

TRIPLE DUTY VALVE FULL OPEN

A - 230/460/3

B - 40.6/20.3

REMARKS:

TRIPLE DUTY VALVE FULL OPEN

A - 230/460/3

B - 40.6/20.3

Nicholasville, KY 859.277.6158
Paducah, KY 270.744.9723



ThermalBalance.com

Ashland, KY 606.325.4832
Nashville, TN 615.768.5461





PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	COOLING TOWER WATER
LOCATION	MECH RM



PUMP DATA SHEET

PUMP NO.	P-5		
MANUFACTURER	B&G		
SIZE	SERIES 1510 4BC		
IMPELLER	9"		
SERVICE	COOLING TOWER WATER		

PUMP NO.	P-6		
MANUFACTURER	B&G		
SIZE	SERIES 1510 4BC		
IMPELLER	9"		
SERVICE	COOLING TOWER WATER		

TEST DATA	GPM	FT. HD.	BHP
DESIGN	650	65	
ACTUAL	700	62	
DISCHARGE			
SUCTION			
DELTA P		*2.307=	FT. HD.

TEST DATA	GPM	FT. HD.	BHP
DESIGN	650	65	
ACTUAL	700	62	
DISCHARGE			
SUCTION			
DELTA P		*2.307=	FT. HD.

BLOCK OFF	79 FT. HD.		
DISCHARGE			
SUCTION			
DELTA P	*2.307=		

BLOCK OFF	79 FT. HD.		
DISCHARGE			
SUCTION			
DELTA P	*2.307=		

MOTOR MFG	BALDOR		
HORSEPOWER	-----		
RPM	1760		
VOLTS	A	ACT.	208 / 3 /
AMPS	B	ACT.	35.7 / 33.9 / 35.6
OVERLOADS	GE F487B (37.7-41.9)		

MOTOR MFG	BALDOR		
HORSEPOWER	-----		
RPM	1760		
VOLTS	A	ACT.	208 / 3 /
AMPS	B	ACT.	35.6 / 34.0 / 35.9
OVERLOADS	GE 487B (37.7-41.9)		

REMARKS:

TRIPLE DUTY VALVE 14 TURNS FROM FULL OPEN
 A - 230/460/3
 B - 40.6/20.3

REMARKS:

TRIPLE DUTY VALVE 14 TURNS FROM FULL OPEN
 A - 230/460/3
 B - 40.6/20.3

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PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	CONDENSER WATER
LOCATION	



FLOW METER

LOCATION	STATION DESIGNATION	SIZE	DESIGN GPM	ACTUAL GPM	NOTATION
					HAYS AUTO 2 - 80 #
MECH RM	HP-144	1½	35.0	35.0	9 #
MECH RM	HP-036	¾	10.0	10.0	10
MECH RM	HP-144	1½	35.0	35.0	10
B-12	HP-012	¾	3.0	3.0	14
B-13	HP-012	¾	3.0	3.0	15
192	HP-031	¾	8.0	8.0	5
133	HP-012	¾	3.0	3.0	3
152	HP-041	¾	10.0	10.0	2
150	HP-024	¾	6.0	6.0	2½
154	HP-015	¾	4.0	4.0	2
134	HP-018	¾	5.0	5.0	1½
123	HP-036	¾	10.0	10.0	2½
137	HP-007	¾	2.0	2.0	7
138	HP-018	¾	5.0	5.0	2
141	HP-018	¾	5.0	5.0	1½
125	HP-007	¾	2.0	2.0	7
B-02	HP-048	1	12.0	12.0	3½
B-02	HP-012	¾	3.0	3.0	2
B-01	HP-060	1	14.0	14.0	2
D.L.	HP-048	1	12.0	12.0	4½

REMARKS:

Nicholasville, KY 859.277.6158
Paducah, KY 270.744.9723



PROJECT NAME

MARSHALL COUNTY JUDICIAL FACILITY

SYSTEM

CONDENSER WATER

LOCATION



FLOW METER

LOCATION	STATION DESIGNATION	SIZE	DESIGN GPM	ACTUAL GPM	NOTATION
					HAYS AUTO 2 - 80 #
D.L.	HP-018	3/4	5.0	5.0	2 #
105	HP-031	3/4	8.0	8.0	4
105	HP-048	1	12.0	12.0	4
106	HP-012	3/4	3.0	3.0	3
115	HP-012	3/4	3.0	3.0	4
118	HP-024	3/4	6.0	6.0	2 1/2
119	HP-007	3/4	2.0	2.0	6 1/2
169	HP-007	3/4	2.0	2.0	6
167	HP-036	3/4	10.0	10.0	2 1/2
178	HP-024	3/4	6.0	6.0	2
161	HP-018	3/4	5.0	5.0	2
163	HP-024	3/4	6.0	6.0	2 1/2
265	HP-024	3/4	6.0	6.0	7
255	HP-024	3/4	6.0	6.0	7 1/2
255	HP-042	3/4	10.0	10.0	6 1/2
257	HP-024	3/4	6.0	6.0	6 1/2
250	HP-042	3/4	10.0	10.0	7
231	HP-012	3/4	3.0	3.0	9
238	HP-024	3/4	6.0	6.0	10
238	HP-028	3/4	7.0	7.0	7 1/2

REMARKS:

Nicholasville, KY 859.277.6158
 Paducah, KY 270.744.9723



Ashland, KY 606.325.4832
 Nashville, TN 615.768.5461





PROJECT NAME	MARSHALL COUNTY JUDICIAL FACILITY
SYSTEM	CONDENSER WATER
LOCATION	



FLOW METER

LOCATION	STATION DESIGNATION	SIZE	DESIGN GPM	ACTUAL GPM	NOTATION
228	HP-007	3/4	2.0	2.0	13½ #
203	HP-042	3/4	10.0	10.0	7
205	HP-015	3/4	4.0	4.0	7
226	HP-042	3/4	10.0	10.0	7½
217	HP-036	3/4	10.0	10.0	5½
218	HP-012	3/4	3.0	3.0	10
218	HP-036	3/4	10.0	10.0	8
285	HP-018	3/4	5.0	5.0	3½
290	HP-018	3/4	5.0	5.0	5½
286	HP-024	3/4	6.0	6.0	7
298	HP-012	3/4	3.0	3.0	9½
278	HP-024	3/4	6.0	6.0	9
280	HP-024	3/4	6.0	6.0	10
					DES WPD ACT WPD
MECH RM	(1)	-----	450.0	416.0	14.6' 12.5'
MECH RM	(2)	-----	650.0	638.0	16.8' 16.2'

REMARKS:

- 1 - HEAT EXCHANGER: SHELL SIDE
- 2 - HEAT EXCHANGER: TUBE SIDE

Nicholasville, KY 859.277.6158
Paducah, KY 270.744.9723

APPENDIX D: FOLLOW-UP TEST AND BALANCE REPORT



Thermal Balance Inc.
152 Burt Rd., Lexington, KY 40503
(859)277-6158

PROJECT NUMBER		PAGE	1 OF 2	DATE	3/14/19
PROJECT NAME	MARSHALL CO JUDICIAL FACILITY				
SYSTEM	ERV-1				
LOCATION	ROOF				



ASSOCIATED AIR BALANCE COUN

ENERGY RECOVERY UNITS

MANUFACTURER	GREENHECK
MODEL #	5225-B-ES
SERIAL #	

	SUPPLY FAN		EXHAUST FAN	
	DESIGN	ACTUAL	DESIGN	ACTUAL
FAN CFM	6800	①	5700	4566
OUTLET CFM	5875	—	4750	—
FAN RPM	—	796	—	1083
STATIC PRESS	—	—	—	—
DISCHARGE SP	—	—	—	—
SUCTION SP	—	—	—	—
DELTA SP ACROSS ARC	—	—	—	—
MOTOR MANUFACTURE	MARATHON		MARATHON	
MOTOR HORSEPOWER	7 1/2	→	7 1/2	→
MOTOR RPM	1760	1784	1760	1783
MOTOR VOLTS PHASE	208-230/460/3	213 1/3	208-230/460/3	213 1/3
MOTOR AMPS	21.4-19.6/9.8	12.6/12.8/11.7	21.4-19.6/9.8	10.8/10.9/11.3
MOTOR SERVICE FACTOR	1.15		1.15	
OVERLOADS	ADJ @ 12.0 (MIN)		ADJ @ 12.0 (MAX Setpoint)	
MOTOR SHEAVE	IVP60 x 1 3/8" → VARI-E-MAX		IVP71 x 1 3/8" → VARI-E-MAX	
FAN SHEAVE	BK130H x H1" → FIXED		BK115H x H1" → FIXED	
BELTS NO.	B71 (1) → VEE		BX71 (1) → VEE	

REMARKS ① REFER TO DUCT TRAVERSE SHEET

(F) (M)
 22 1/4" ← 1 1/2" → 2"
 EXTRA IVP71 x 1 3/8" IN O/A FAN
 CABINET

Beyond DIRTY
 19 3/4" x 15 1/2" x 2 (8)
 METAL PRE-FILTERS

(F) (M)
 22 5/8" ← 1" → 2 1/2"



PROJECT NUMBER	PAGE	2	DATE	3/14/19
PROJECT NAME	MARSHALL Co JUDICIAL FACILITY			
SYSTEM	ERJ-1			
LOCATION	2 ND FL ABOVE CEILING			



ASSOCIATED AIR BALANCE CONS.

Thermal Balance Inc.
152 Burn Rd., Lexington, KY 40503
Phone (859)277-6158
Fax (859)278-1010

DUCT TRAVERSE

ZONE	DUCT SIZE inches	TYPE	AREA ft ²	REQUIRED VELOCITY fpm	REQUIRED CFM	ACTUAL TEST VELOCITY fpm	ACTUAL TEST CFM	DUCT STATIC PRESSURE in. W.G.	R M K S
<i>Supply</i>									
1	16x10	1	1.11	748	830	222	246	-0.21"	①
2	40x18	1	5.0	1009	5045	261	1305	-0.21"	L
1551 TOTAL									
<i>Exhaust</i>									
1	20x14	1	1.94	1134	2200	1046	2029	-0.45"	
2	18x12	1	1.50	900	1350	766	1149	-0.35"	
3	18x14	1	1.75	686	1200	793	1388	-0.33"	
4566 TOTAL									

REMARKS:

① READINGS w/ PRE-FILTERS INSTALLED. (Very Dirty)

② READINGS w/ PRE-FILTERS REMOVED.

APPENDIX E: AIR BALANCE SUMMARY

MARSHALL COUNTY JUDICIAL BUILDING
Air Balance Summary

UNIT	DESIGN (JUNE 2000)		ACTUAL (AUGUST 2002)		PRE (MARCH 2019)		POST (MARCH 2019)	
	SUPPLY (CFM)	EXHAUST (CFM)	SUPPLY (CFM)	EXHAUST (CFM)	SUPPLY (CFM)	EXHAUST (CFM)	SUPPLY (CFM)	EXHAUST (CFM)
ERV-1	6,800	5,700	5,531	4,560	1,551	4,566	4,332	4,566
OVERALL	1,100		971		(3,015)		(234)	

NOTES:

1. Excluded VF-1 from the calculations due to it being configured for summer ventilation of the connecting corridor.

APPENDIX F: ERV SUBMITTAL

SUBMITTAL

Job Title: Marshall County Courthouse

Elevation: (ft) 489

Date: 3/01/2019

Submitted By: Shane Leavell

R L CRAIG COMPANY INC
11524 COMMONWEALTH DR
LOUISVILLE, KY 40299
US

Phone: (502)244-1600

Fax: (502)245-1462

Email Address: shane@rlcraigco.com



Building Value in Air.

P.O. Box 410 Schofield, WI 54476 (715) 359-6171 FAX (715) 355-2399 www.greenheck.com

Generated by: shane@rlcraigco.com

J:\Shane and Mary\DSL & MEB 2019 CAPS\Marshall County Courthouse.gfcj

ERV-90-15L

Unit Performance

Design Conditions														
Elevation (ft)	Summer		Winter DB (F)		Outdoor Air (CFM)		Exhaust Air (CFM)							
	DB (F)	WB (F)												
489	95.0	78.7		0.0		6,800		5,700						
Unit Specifications														
Qty	Weight (lb)		Unit Installation			Unit ETL Listing								
1	2,850 (+/- 5%)		Outdoor			UL\cUL 1995								
Configuration														
Outdoor Air				Exhaust Air										
Intake		Discharge		Intake		Discharge								
End		Bottom		Bottom		Side								
Energy Recovery Performance														
Design Condition	Temperature (F)							Capacity Reduction (BTU/h)						
	Outdoor Air		Supply Air		Return Air		Exhaust Air							
DB	WB	DB	WB	DB	WB	DB	WB							
Summer	95.0	78.7	80.8	68.6	75.0	62.5	91.9	75.8						
Winter	0.0	-1.5	50.2	41.7	70.0	54.3	10.1	10.1						
Air Performance														
Type	Total Volume (CFM)		External SP (in. wg)		Total SP (in. wg)		Fan							
	Supply		0.4		0.767		Qty							
Exhaust		5,700		0.4		1147		Type						
						1		Forward Curve						
								Belt						
Motor Specifications														
Motor		Qty		Operating Power (hp)		Size (hp)		Efficiency						
Supply		1		6.62		7-1/2		PE						
Exhaust		1		4.08		5		ODP						
Electrical Specifications														
Power Supply		Rating (V/C/P)			MCA (A)		MOP (A)							
Unit		208/60/3			49.4		60.0							

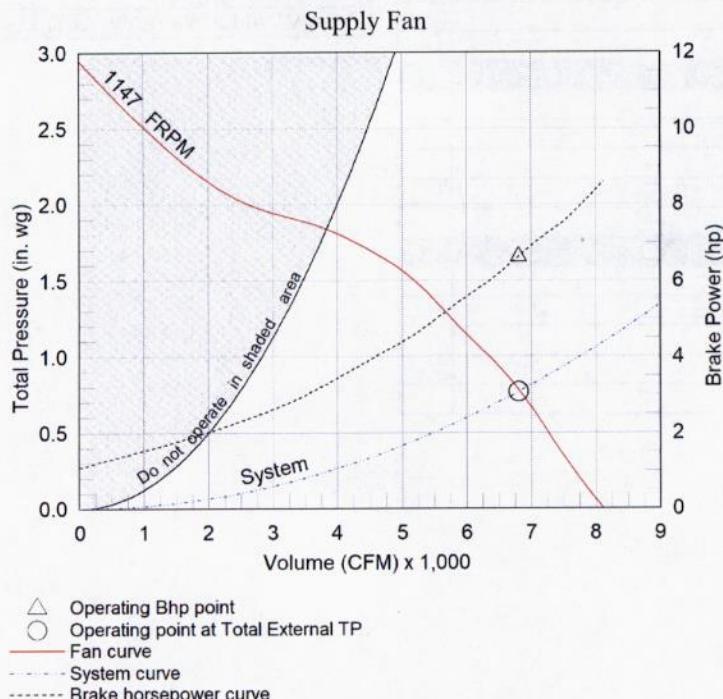
CONSTRUCTION FEATURES AND ACCESSORIES

Unit		Accessories	
UL-1995	Std	Frost Control	
Unit Installation - Outdoor	Std	Roof Curb - - 80.5/120.38-G	
Energy Recovery Device - Polymer Wheel w/ Silica Gel Desiccant	Std	Outdoor Air Filters - 2" MERV 8, 7-16x25	Std
Unit Construction - Single Wall	Std	Exhaust Air Filters - 2" MERV 8, 7-16x25	Std
Insulation - 1 inch 3# R4 fiberglass	Std	Outdoor Air Damper	
Corrosion Resistant Fasteners	Std	Return Air Damper	
Hinged Access		Damper End Switch	
Factory Wired Non-Fused Disconnect Switch	Std	Service Outlet	
Two Direct Drive Forward Curved Blower and Motor Assemblies		Spare Filters	
Unit Finish - Galvanized	Std	Spare Energy Wheel Belt	
Fan VFDs		Spare Energy Wheel Segments	
Single Point Power	Std	Spare Fan Belts	
Disconnected Switch, non-fused	Std	Speed Control	
Vari-Green EC Motors		Warranty Options	
Short Circuit Current - 5 kA	Std	Unit Warranty - 1 Yr	Std
Controls		Energy Wheel Warranty - 5 Yrs Less Motor	
Network Interface		Standard Option	
Network Protocol		Not Included	
Energy Wheel Economizer Control		Included	
Exhaust Only Operation		<input checked="" type="checkbox"/>	
Rotation Sensor			
Control Accessories			
Remote Display			
Room Sensing			
CO2 Sensor			
Dirty Filter Sensor(s)			
Wheel Rotation Sensor			

Supply Fan Charts And Performance

Supply Fan Performance					Motor		Fan		
Total Volume (CFM)	External SP (in. wg)	Total SP (in. wg)	RPM	Operating Power (hp)	Qty	Size (hp)	Qty	Type	Drive-Type
6,800	0.4	0.767	1147	6.62	1	7-1/2	1	Forward Curve	Belt

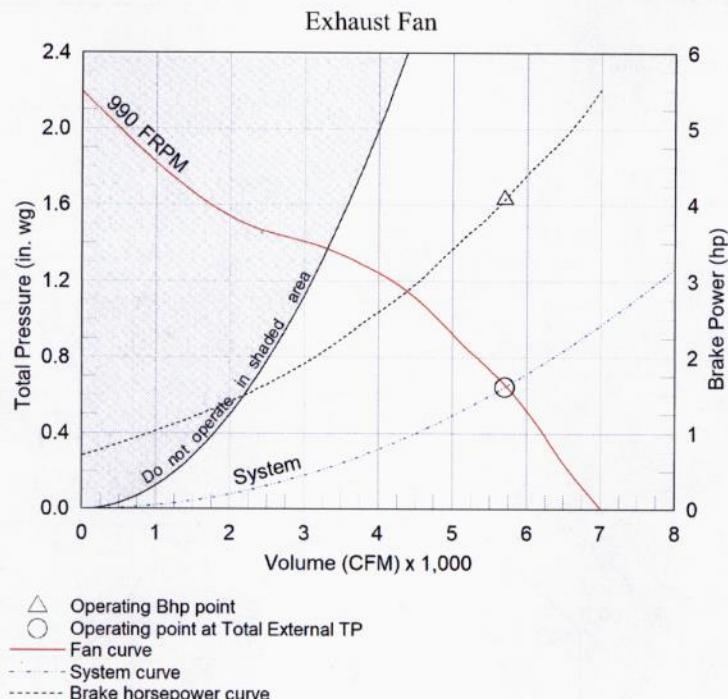
Pressure Drop (in. wg)				
Weatherhood	Filter	Damper	External	Total
0.186	0.181	-	0.4	0.767



Exhaust Fan Charts And Performance

Exhaust Fan Performance						Motor			Fan		
Total Volume (CFM)	External SP (in. wg)	Total SP (in. wg)	RPM	Operating Power (hp)		Qty	Size (hp)	Qty	Type	Drive-Type	
5,700	0.4	0.643	990	4.08		1	5	1	Forward Curve	Belt	

Pressure Drop (in. wg)					
Weatherhood	Filter	Damper	External	Total	
0.116	0.127	-	0.4	0.643	



Energy Recovery Summer Performance

Outdoor Air		Supply Air	
Dry Bulb (F)	95.0	Dry Bulb (F)	80.8
Wet Bulb (F)	78.7	Wet Bulb (F)	68.6
Specific Humidity (gr/lb)	125	Specific Humidity (gr/lb)	87
Enthalpy (BTU/lb)	42.6	Enthalpy (BTU/lb)	33.0

Exhaust Air		Return Air	
Dry Bulb (F)	91.9	Dry Bulb (F)	75.0
Wet Bulb (F)	75.8	Rel. Humidity (%)	50
Specific Humidity (gr/lb)	76	Specific Humidity (gr/lb)	66
Enthalpy (BTU/lb)	39.8	Enthalpy (BTU/lb)	28.3

Design Air Flow Conditions

Model	OA Volume (CFM)	OA Wheel Enthalpy Recovery Ratio	EA Volume (CFM)	EA Wheel Effectiveness
ERV-90-15L	6,800	67.3	5,700	80.3

Outdoor Air Cooling Reduction

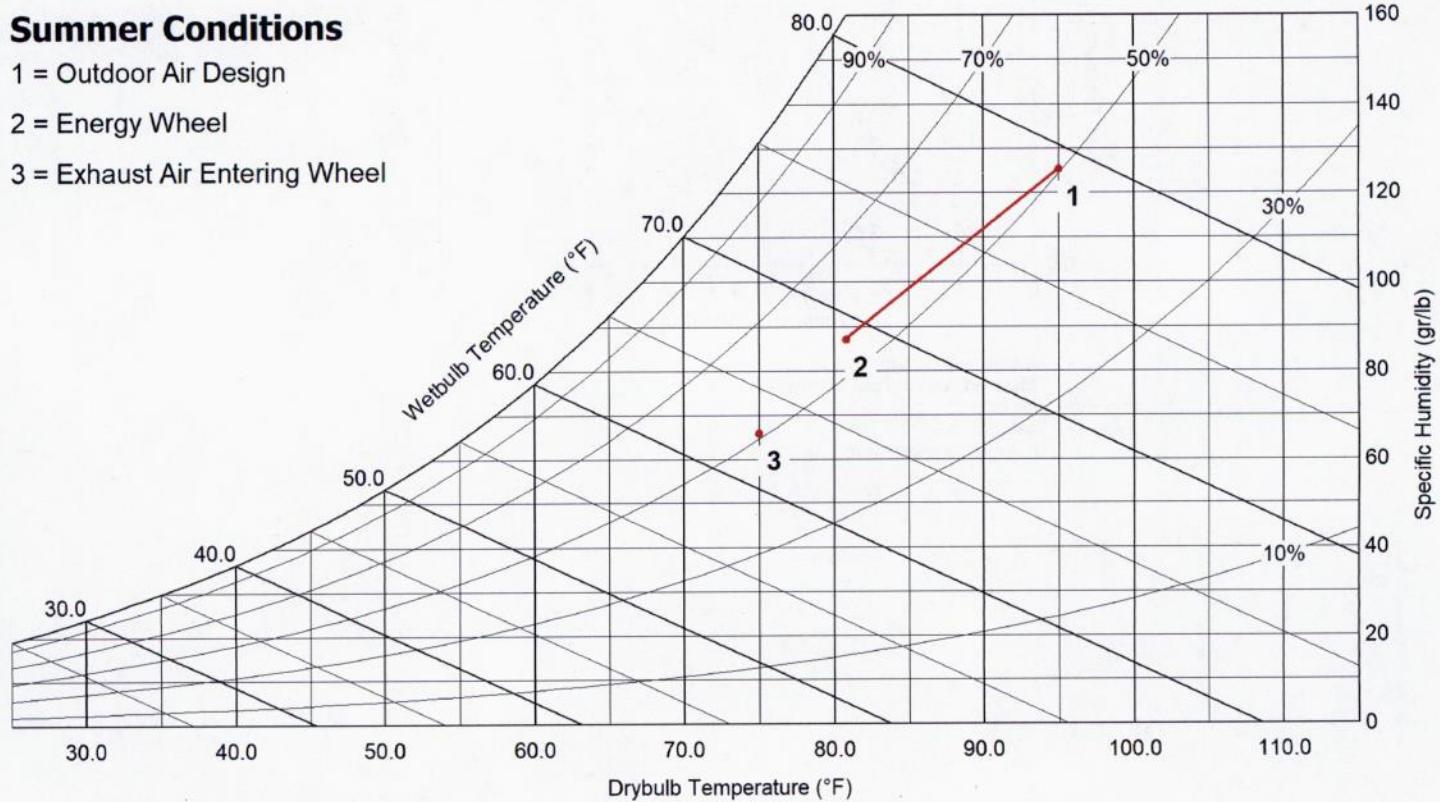
(BTU/h)	(tons)	OA Load with Energy Recovery		Equipment Reduction (tons)
		(BTU/h)	(tons)	
437,580.0	36.47	143,820.0	11.99	24.48

Summer Conditions

1 = Outdoor Air Design

2 = Energy Wheel

3 = Exhaust Air Entering Wheel



Energy Recovery Winter Performance

Outdoor Air		Supply Air
Dry Bulb (F)	0.0	Dry Bulb (F) 50.2
Wet Bulb (F)	-1.5	Wet Bulb (F) 41.7
Specific Humidity (gr/lb)	3	Specific Humidity (gr/lb) 26
Enthalpy (BTU/lb)	0.4	Enthalpy (BTU/lb) 16.2
Exhaust Air		Return Air
Dry Bulb (F)	10.1	Dry Bulb (F) 70.0
Wet Bulb (F)	10.1	Rel. Humidity (%) 35
Specific Humidity (gr/lb)	11	Specific Humidity (gr/lb) 39
Enthalpy (BTU/lb)	4.0	Enthalpy (BTU/lb) 22.8

Design Air Flow Conditions

Model	OA Volume (CFM)	OA Wheel Enthalpy Recovery Ratio	EA Volume (CFM)	EA Wheel Effectiveness
ERV-90-15L	6,800	70.4	5,700	84

Outdoor Air Heating Reduction

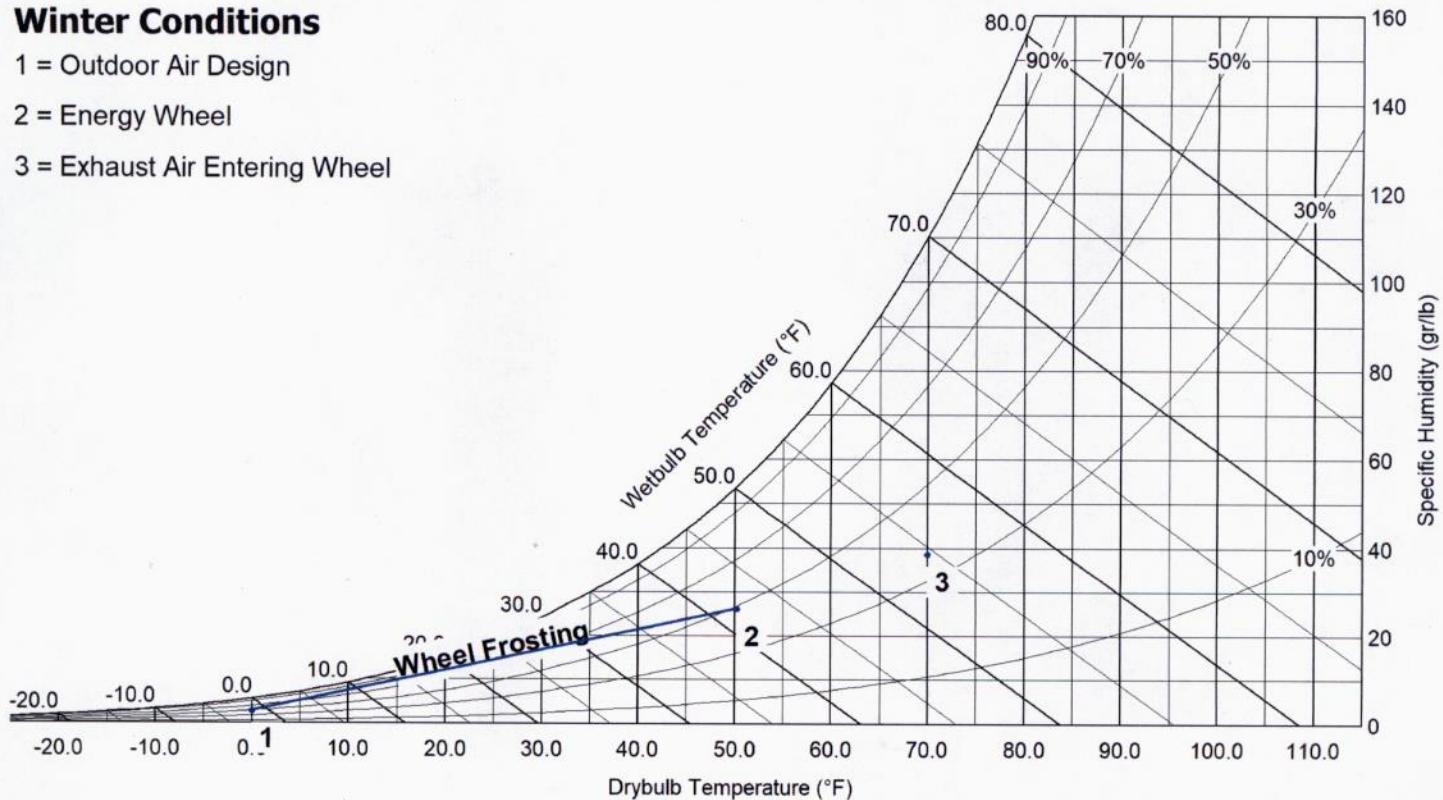
OA Load w/o Energy Recovery (BTU/h)	OA Load with Energy Recovery (BTU/h)	Equipment Reduction (BTU/h)
518,364.0	146,623.0	371,741.0

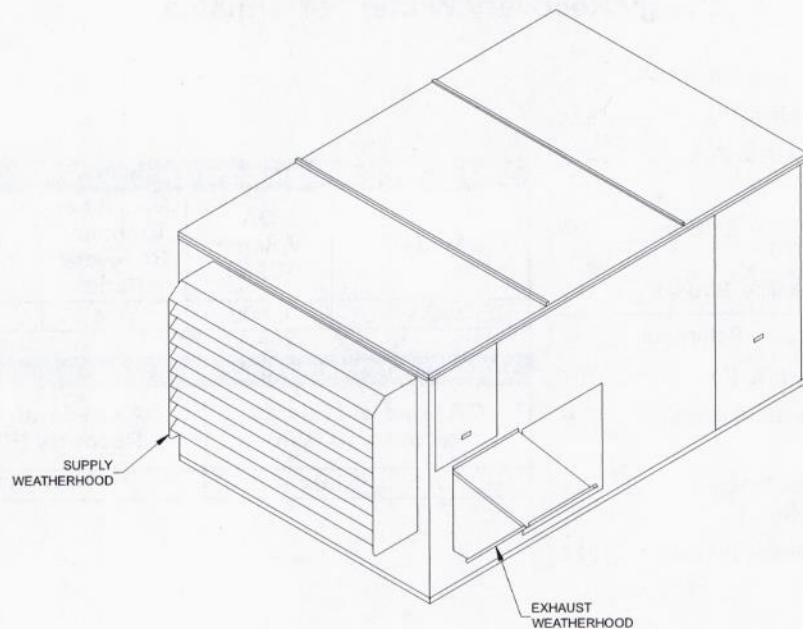
Winter Conditions

1 = Outdoor Air Design

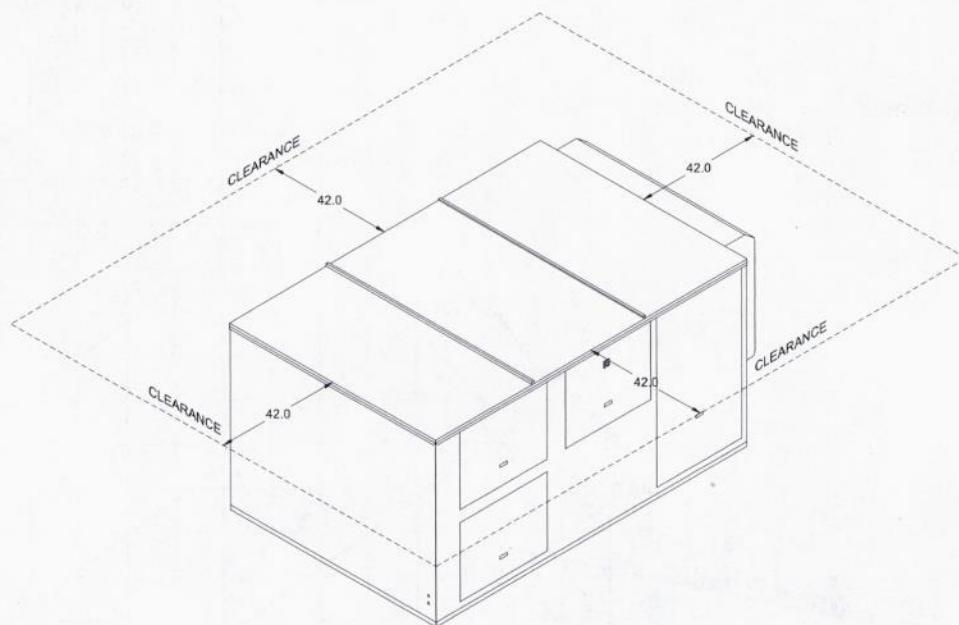
2 = Energy Wheel

3 = Exhaust Air Entering Wheel



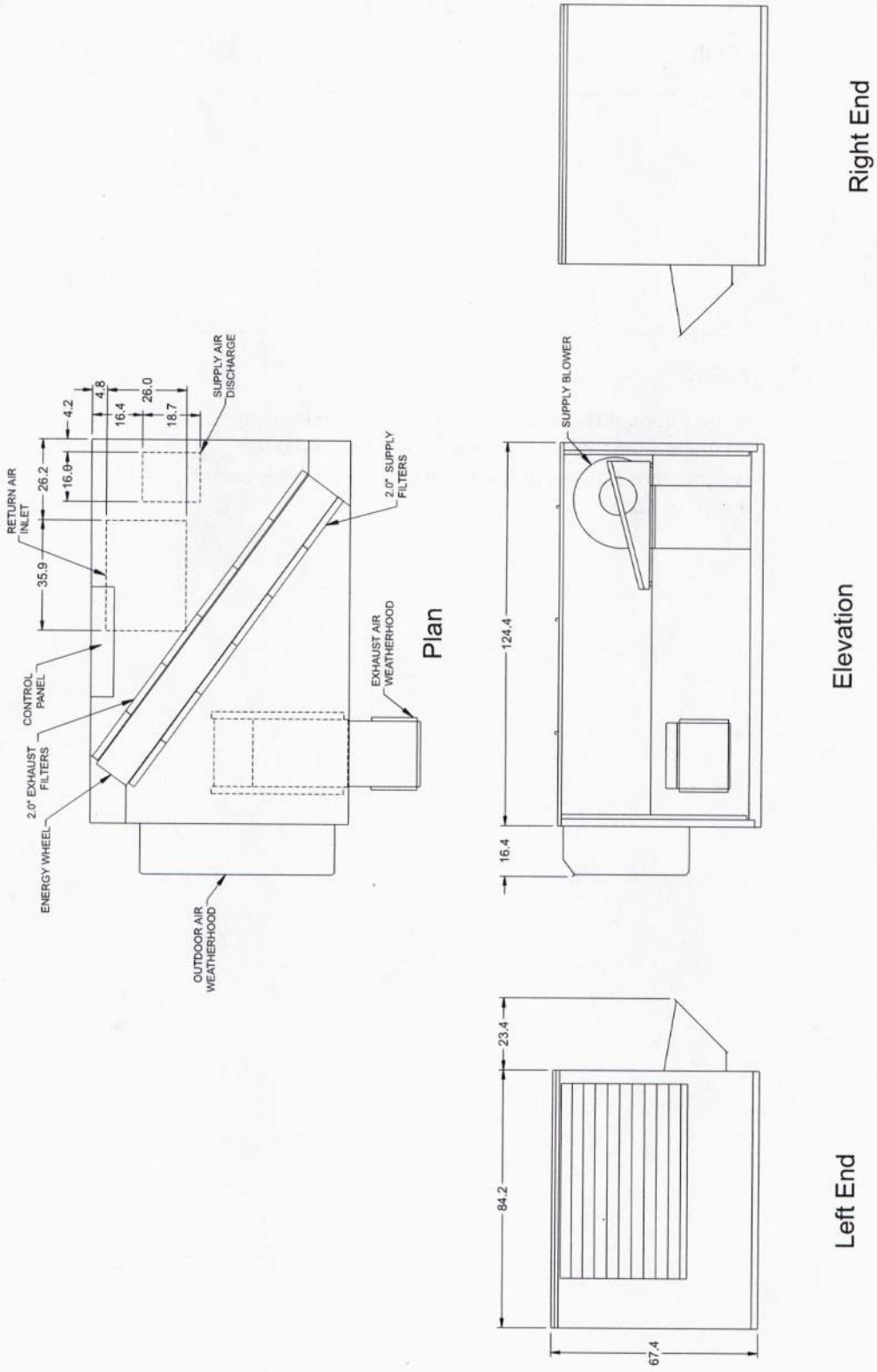
ISOMETRIC DRAWINGS

Back Right Isometric



Front Left Isometric

OVERVIEW DRAWINGS



Corner Weights

747 lb

661 lb

Unit

765 lb

677 lb

Note: Estimated corner weights are shown looking down
on unit and the outside air intake will be on the left.

Weights are applied at the base of the unit. Images not
drawn to scale.

TERMINAL STRIP CONTROLS

BASIC UNIT CONTROLS: The Energy Recovery Unit will be provided from the factory with an integral control center including: a single non-fused disconnect, 24 VAC transformer, terminal strip, fan contactors and overloads and energy wheel contactor.

ON/OFF CONTROL: Within the unit control center, a digital signal must be field wired into the terminal strip (connecting terminals R and G) to control unit startup or shutdown.

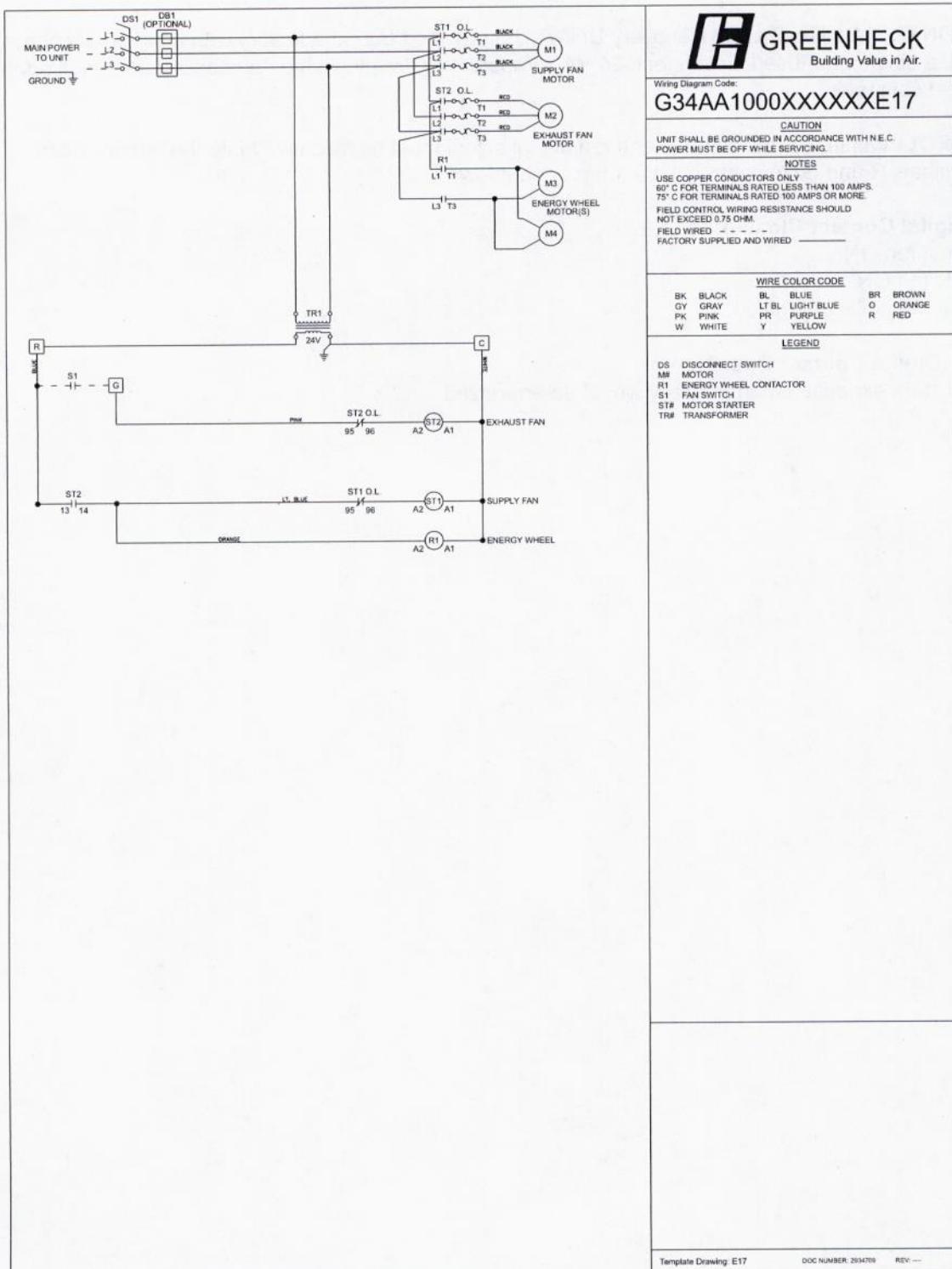
Startup (Digital Contact Closes)

- Exhaust fan ON.
- Supply fan ON.
- Energy Wheel is energized.

Shutdown (Digital Contact Opens)

- Supply fan, exhaust fan and energy wheel de-energized.

WIRING DIAGRAM



Warranty Statement for ERV Preconditioners

Unit Warranty

Greenheck warrants the equipment to be free from defects in material and workmanship for a period of 1 year (standard) from the shipment date.

Energy Wheel Warranty

The energy recovery wheel is warranted to be free from defects in material and workmanship for a period of 5 years from the shipment date.

Warranty Notes

Any component which proves defective during the warranty period will be repaired or replaced at Greenheck's sole option when returned to our factory, transportation prepaid. All warranties do not include labor costs associated with troubleshooting, removal, or installation. Greenheck will not be liable for any consequential, punitive, or incidental damages resulting from use, repair, or operation of any Greenheck product. These warranties are exclusive and are in lieu of all other warranties, whether written, oral, or implied, including the warranty of merchantability and the warranty of fitness for a particular purpose. No person (including any agent or salesperson) has authority to expand Seller's obligation beyond the terms of this warranty, or to state that the performance of the product is other than that published by Seller.

As a result of our commitment to continuous improvement, Greenheck reserves the right to change specifications without notice.

APPENDIX G: ENERGY RECOVERY SUMMARY

MARSHALL COUNTY JUDICIAL BUILDING
Energy Recovery Summary

Assumed Enthalpy Target (74° F / 50% RH):

27.93
(BTU / LB DA)

SUBMITTED PARAMETERS	SUPPLIED ENTHALPY (°F db / °F wb)	COMPARATIVE ANALYSIS ENTHALPY DIFFERENCE (TARGET VERSUS SUPPLY)
80.8° F / 68.6° F	33.00	(5.07)

NOTES:

1. Supplied Enthalpy derived from R.L. Craig Co. Submittal dated 03/01/2019 (*Appendix F*).