UNDERSTANDING TESTING AND BALANCING REPORTS
MMC 15

- Kevin Macauley
- The State of The Test and Balance Industry Today
- What is Testing and Balancing?
- Certified Firms
- Certification Process
- Procedural Standards
- Test Instruments
- Required Information on Test Reports
- Reading Test Reports
- Questions and Answers

KEVIN MACAULEY

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- CERTIFICATIONS/ACCREDITATIONS
- NEBB (National Environmental Balance Bureau)
- Certified NEBB Professional 1995-Present
- Certified NEBB Exam Proctor (Technician and Certified Professional)
- Instructor NEBB Technician and Certified Professional Program
- Adjunct Instructor Oakland Community College-Auburn Hills MI
- TABB Instructor Sheetmetal Workers Local 7
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- OFFICES:
- MEBB (Michigan Chapter of the National Environmental Balance Bureau)
- Current President - MEBB
- Current Member - Board of Directors MEBB
-
- WORK EXPERIENCE:
- 1979-1994: Testing and Balancing Technician, Aerodynamics Inspecting Company
- 1994-1996: Owner/Certified Professional, Total Balance Company
- 1996-2011: Certified Professional, Enviro-Aire/Total Balance Company
- 2011-Present: Certified Professional/Supervisor, Ener-Tech Testing
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WHAT IS TESTING?

- Testing: The use of specialized and calibrated instruments to measure parameters such as temperature, pressure, vapor flow, airflow, fluid flow, fluid quantities, rotational speed, electrical characteristics, velocity, sound and vibration level, air and hydronic quantities, and other data in order to determine performance, operation, or function.

WHAT IS BALANCING ?

Balancing: The methodical proportioning of air and hydronic flows through the system mains, branches, and terminal devices using acceptable procedures to achieve the specified airflow or hydronic flow within installation, testing and design limitations.

TESTING AND BALANCING CERTIFICATION BODIES

- AABC (Associated Air Balance Counsel)

  As the complexity of HVAC systems began to increase in the 1960s, a small group of engineers founded the Associated Air Balance Council (AABC) as a non-profit association in 1965. Early on, they recognized the need for independence and stringent membership requirements to ensure objectivity, integrity, and technical expertise, and they made these the guiding principles of the association. AABC also developed the first comprehensive industry standards for test and balance.

TESTING AND BALANCING CERTIFICATION BODIES

- TABB (Testing, Adjusting and Balance Bureau)

SMACNA ENDORSEMENT

CREATED BY THE SHEETMETAL WORKERS INTERNATIONAL ASSOCIATION

CERTIFICATION PROCESS SIMILAR TO NEBB

TESTING AND BALANCING CERTIFICATION BODIES

NEBB NATIONAL ENVIRONMENTAL BALANCE BUREAU

- NEBB is a not-for-profit organization founded in 1971 to:
- a) Develop standards, procedures and programs for Building Systems Commissioning, Cleanroom Performance Testing, Fume Hood Performance Testing, Retro-Commissioning and Building Enclosure Testing, Sound Level Testing, Testing-Adjusting-Balancing Environmental Systems and Vibration Testing,
- b) Promote advancement of the industry through technical training and development.
- c) Operate programs to certify firms and qualify individuals who meet and maintain NEBB standards.

CERTIFICATION OF FIRMS

- NEBB certifies firms that meet certain criteria, ensuring strict conformance to NEBB's Procedural Standard. Among other requirements, NEBB CFs must document a record of responsible performance and own a complete set of instruments as listed in Table 4.1. The firm must employ a NEBB CP for each discipline in which the firm is certified

CERTIFIED INDIVIDUALS IN BALANCING

- NEBB Certified Professional (CP): An individual who has successfully passed the professional level certification examinations and maintains the CP re-certification requirements of NEBB.
- NEBB Certified Technician (CT): An employee of the firm who has met the technician level experience requirements of NEBB and has successfully passed the technician level certification examinations. A CT shall be supervised by a NEBB Certified TAB Professional

CERTIFIED PROFESSIONAL

- 2.1.3 CERTIFICATION OF PROFESSIONAL CPs are responsible for the supervision of all work performed by the CF and its employees. CPs must possess a strong grasp of engineering principles, system design, system equipment and procedures. They must also demonstrate proficiency in execution of the work including problem solving, troubleshooting, field measurements, proper use of instruments and performance of the actual work in the field

NEBB TAB TECHNICIAN CERTIFICATION

- NEBB TAB Technician
- Certification
- • Implementation: Define the education &
- experience requirements.
- ▫ Four years (1000 hours minimum per year) or
- more of TAB fieldwork.
- ▫ Two years (1000 hours minimum per year) or
- more of TAB Fieldwork & has successfully
- completed the NEBB TAB Technician Home
- Study Course.
- ▫ Successfully completed a program equivalent to
- NEBB's Technician Qualification testing
- program. Typically an instructional seminar.
- ▫ Practical skills affirmed and stipulated by firms CP and Chapter TCC

QUALITY ASSURANCE PROGRAM

- The credibility of NEBB is built by maintaining integrity through high standards, quality programs, and demonstrated capabilities of its CFs. As further assurance, NEBB offers a Quality Assurance Program to guarantee that the work will be accomplished in accordance with its standards. The NEBB Certificate of Conformance may be provided if specified or requested, but is not mandatory

REQUIRED INSTRUMENTATION

- **Table 4.1 Instrumentation List – IP Units FUNCTIONS/INSTRUMENT TYPE MINIMUM RANGE ACCURACY RESOLUTION CALIBRATION INTERVAL**
- Rotation Measurement 0-5000 RPM ± 2% of reading (12 month calibration interval)
- Temperature Measurement (AIR) -40 to 240 degree F ± 0.5% of reading (12 month calibration interval)
- Temperature Measurement (IMMERSION)-40 to 240 degree F ± 0.5% of reading (12 month calibration interval)
- Temperature Measurement (SURFACE)-40 to 240 degree F ± 0.5% of reading (12 month calibration interval)
- Electrical Measurement - CAT III True RMS Volts AC 0 to 600 VAC ± 2% of reading ± 5 digits Amperes 0 to 100 Amps ± 2% of reading (12 month calibration interval)
- Air Pressure Measurement 0 to 10.00" w.g. ± 2% of reading 0.001" w.g (12 month calibration interval)
- Air Velocity Measurement 50 to 3900 fpm ±5% of reading (12 month calibration interval)
- Hot Wire Anemometer OR Airfoil with Digital Meter Air Velocity Measurement 50 to 2500 fpm ± 2% of reading (12 month calibration interval)
- Rotating Vane Anemometer Velocity Measurement 50 to 2500 fpm +/- 2% of reading (12 month calibration interval)
- Humidity Measurement 10 to 90% RH ± 3% RH (12 month calibration interval)
- Direct Reading Hood 100 to 2000 cfm ± 5% of reading ± 7 cfm (now required to be returned with Shortridge air data multi meter) (12 month calibration interval)
- Hydronic Pressure Measurement (-30" h.g. to 60 PSI ± 2% of reading) (0 to 100 PSI ± 2% of reading) (0 to 200 PSI ± 2% of reading) (12 month calibration interval)
- Hydronic Differential Pressure Measurement (0 to 100" w.g +/- 2% of reading) (0 to 200' ± 2% of reading) (0 to 100 PSI +/- 2% of reading)

TACHOMETER USED FOR MEASURING FAN SPEED

ACCURACY 0-5000 RPM +/- 2%
CALIBRATION INTERVAL 12 MONTHS

TEMPERATURE METER TO BE USED WITH PROBES

ACCURACY: -40 TO 240 DEGREE F +/- 5%
CALIBRATION INTERVAL 12 MONTHS

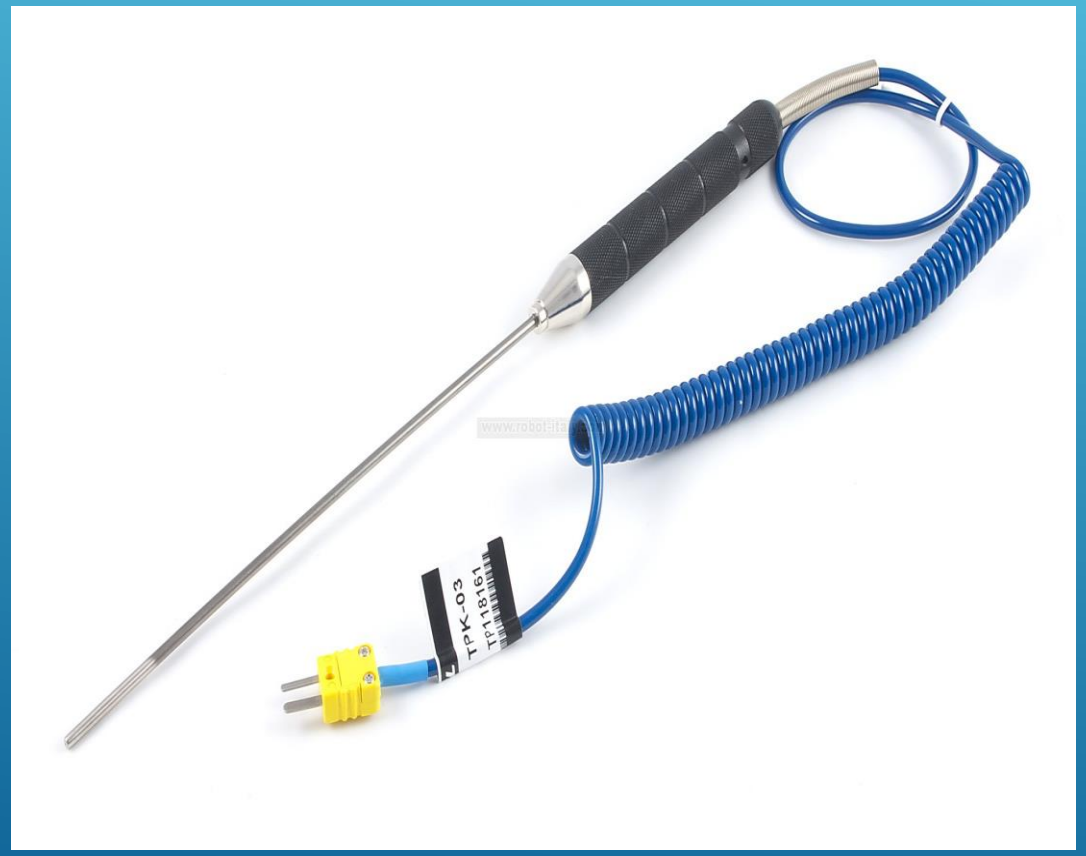
K- TYPE THERMOCOUPLE AIR PROBE

ACCURACY: -40 TO 240 DEGREE F +/- 5%
CALIBRATION INTERVAL 12 MONTHS

SURFACE READING PROBE

ACCURACY: -40 TO 240 DEGREE F +/- 5%
CALIBRATION INTERVAL 12 MONTHS

IMMERSION TEMPERATURE PROBE



ACCURACY: -40 TO 240 DEGREE F +/- 5%
CALIBRATION INTERVAL 12 MONTHS

CLAMP TYPE MULTI METER

AC VOLTS 0-600 VAC +/- 2% OF READING
AMPERES 0-100 AMPERES +/- 2% OF READING
12 MONTH CALIBRATION INTERVAL

AIR PRESSURE/VELOCITY MEASUREMENT MULTI METER

AIR PRESSURE MEASUREMENT
0-10.0" WG RANGE .001" RESOLUTION
AIR VELOCITY MEASUREMENT
50-3900 FPM +/- 5% OF READING
12 MONTH CALIBRATION

SHORTRIDGE VELGRID FOR VELOCITY MEASUREMENT CONNECTS TO SHORTRIDGE AIR MULTI-METER

CALIBRATION NOT REQUIRED

VELOCITY AND PRESSURE PROBES(PITOT TUBE, AIR FOIL, STATIC PRESSURE PROBES) VELGRID EXTENSION POLES

CALIBRATION NOT REQUIRED

SHORTRIDGE TEMPERATURE PROBES (WILL CONNECT TO AIR DATA METER

ACCURACY: -40 TO 240 DEGREE F +/- 5%
CAN BE CALIBRATED THRU SHORTRIDGE
CALIBRATION INTERVAL 12 MONTHS

FLOW HOOD

ACCURACY
100-2000 CFM RANGE +/- 5% +/-7 CFM
REQUIRED TO BE SHIPPED BACK WITH THE SHORTRIDGE AIR DATA METER

HOT WIRE ANEMOMETER - VELOCITY

AIR VELOCITY MEASUREMENT
50-3900 FPM +/- 5% OF READING
12 MONTH CALIBRATION

ROTATING VANE ANEMOMETER

AIR VELOCITY MEASUREMENT
50-3900 FPM +/- 5% OF READING
12 MONTH CALIBRATION

HUMIDITY METER

HUMIDITY METER
10-90% +/- 3%
12 MONTH CALIBRATION

HYDROMETER MULTI-METER

HYDRONIC PRESSURE MEASUREMENT ACCURACY
-30" HG TO 60 PSI +/- 2%
0-100 PSI +/- 2%
0-200 PSI +/- 2%

HYDRONIC DIFFERENTIAL PRESSURE MEASUREMENT ACCURACY
0-100" +/- 2%
0-200' +/- 2%
0-100 PSI +/- 2%

12 MONTH CALIBRATION

ULTRA-SONIC HYDRONIC FLOW METER

NO CALIBRATION STANDARD AS OF 9/10/17

WHAT IS A BALANCE REPORT?

- NEBB Certified TAB Report: The data presented in a NEBB Certified TAB Report accurately represents system measurements obtained in accordance with the current edition of the NEBB Procedural Standard for Testing, Adjusting, and Balancing of Environmental Systems. A NEBB Certified TAB Report does not necessarily guarantee that systems included are balanced to design flows. Any variances from design quantities, which exceed NEBB tolerances or contract document tolerances, are noted in the test-adjust-balance report project summary.

REQUIRED INFORMATION FOR A TESTING AND BALANCING REPORT

- Required: Designates any data, function or action that must be gathered or performed to qualify as a NEBB certified report, unless such data is impossible to gather or a given function or action cannot be performed. Any information or action that cannot be fulfilled in accordance with this Procedural Standard must be clearly explained in the final report summary.

REQUIRED INFORMATION AIR APPARATUS TEST REPORT – FAN MANUFACTURER

- a) Unit Designation Design
- b) Manufacturer Installed
- c) Model Number Installed
- d) Serial Number Installed
- e) Type Installed
- f) Service Design
- g) Area Served Design
- h) Location. Design
- i) Unit Cross Sectional Sketch or Static Pressure Profile Actual

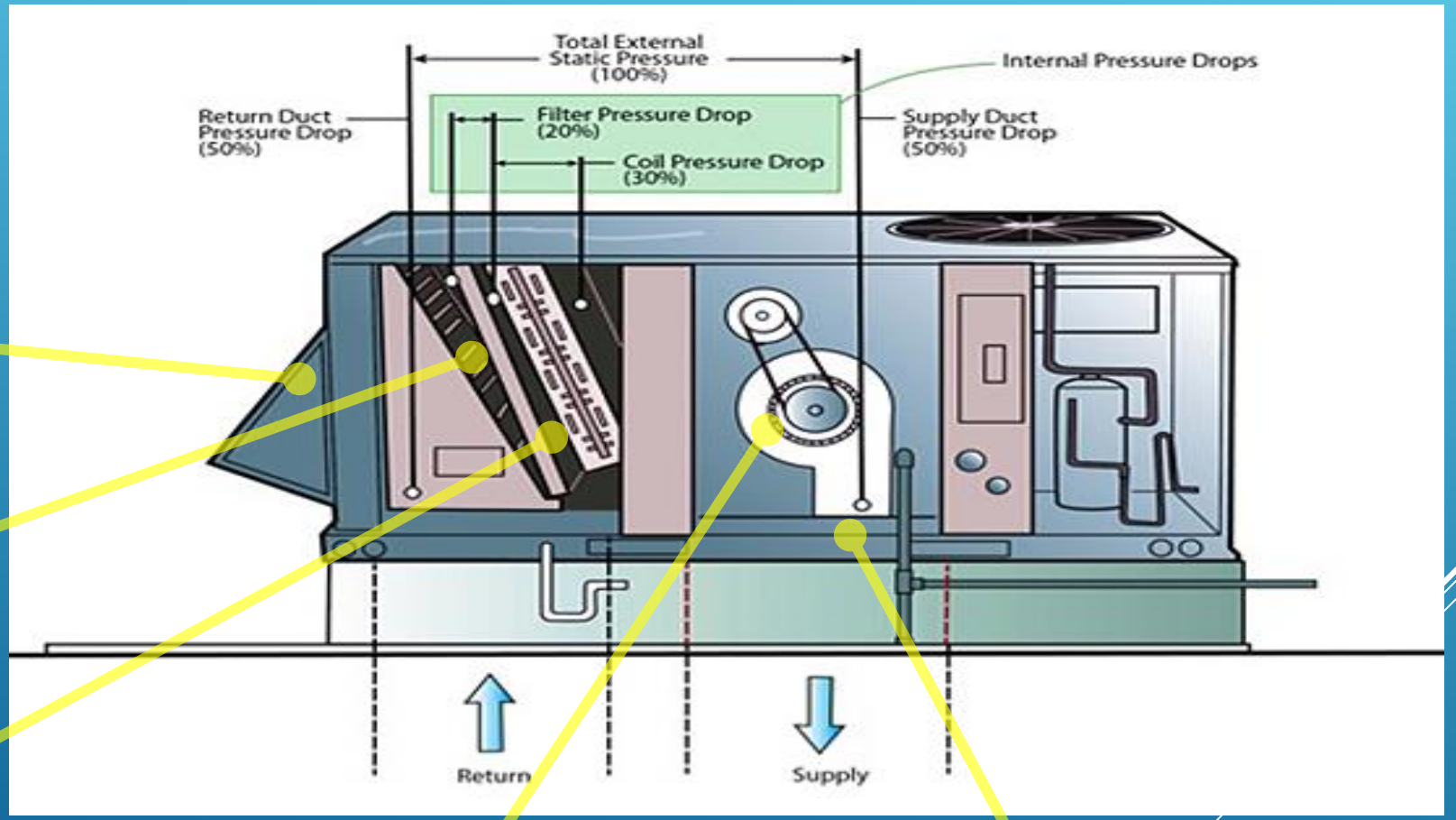
REQUIRED MOTOR INFORMATION

- a) Manufacturer Installed
- b) Horsepower Installed
- c) Frame Installed
- d) Full Load Amps Installed
- e) Service Factor Installed
- f) Volts Nameplate & Actual
- g) Corrected Nameplate Amps Actual
- h) Operating Amps Actual
- i) Brake Horsepower Actual

BELT DRIVE AIR APPARATUS

- a) Motor Sheave Manufacturer/PD/bore Installed
- b) Fan Sheave Manufacturer/PD/bore Installed
- c) C to C Distance Installed
- d) Belt Manufacturer/quantity/size Installed

TYPICAL ROOF TOP UNIT



Outside Air Hood

Before filter pressure

After filter pressure

Fan Suction Pressure

Fan discharge pressure

FAN SHEET (AIR APPARATUS REPORT)

Ener-Tech Testing

NEBB Certification #3486

Air Apparatus Test Report

Project: Animal Surgical Center of Michigan **Unit Number:** RTU-1

Area Served: Exam Room Supply **Location:** Roof

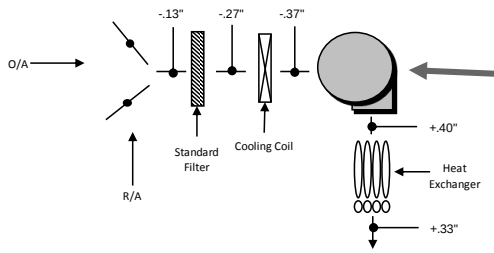
Fan / Unit Data		
Make	Trane	
Model	YSC048E3RMA	
Type / Size	~	~
Class/Arrangement	~	~
Serial Number	150911873L	
Discharge	~	
Fan Drive Information		
Sheave Diameter	AK49	
Shaft Size	3/4"	
No. Belts/Size	1	AX26

Motor Data			
Manufacturer	Marathon		
H.P. / Amps	1.0		4.0
Ph./Hertz/Volts	3	60	208
Frame / RPM	56		1725
Ser. Factor/P. F.	1.50		~
Efficiency:	~		
Motor Drive Information			
Sheave Diameter	1VL30 (Min)		
Shaft Size (Bushing)	5/8"		
CL to CL Distance	8.5"		
Motor Adjustment	+ 2.0"		- 3.0"

Test Data	Design	Actual
Total CFM	1600	**1316**
Return Air CFM	1280	**824**
Minimum OA CFM	320	**492**
Total S.P.	~	**0.77"**
External S.P.	0.80"	**0.46"**
Fan RPM	1036	**800**
Brake Horsepower	0.73	**0.51**
Electrical Test Data		
Motor Amps T1 T2 T3	**1.90**	**2.00** **2.20**
Motor Volts T1 T2 T3	**207**	**206** **207**
V.F.D. Setting	**None**	
Motor Frequency	**60Hz**	
Thermal Overloads	**Thermally Protected**	

Test Data	Design	Actual
Fan Discharge S.P.	~	**+0.40"**
Fan Suction S.P.	~	**-0.37"**
Total S.P.	~	**0.77"**
Component Pressure Drops		
Filter:	~	**0.14"**
Cooling Coil:	~	**0.10"**
Heat Exchanger:	~	**0.70"**
Test Conditions		
Return Air Damper	~	**Open**
Outside Air Damper	~	**Min**
Relief Air Damper	~	**~**

Remarks/Schematics: **Connected Load 1475cfm. RTU-1 has hot gas bypass**



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Fan Manufacturers Information

Design and Actual Test Data

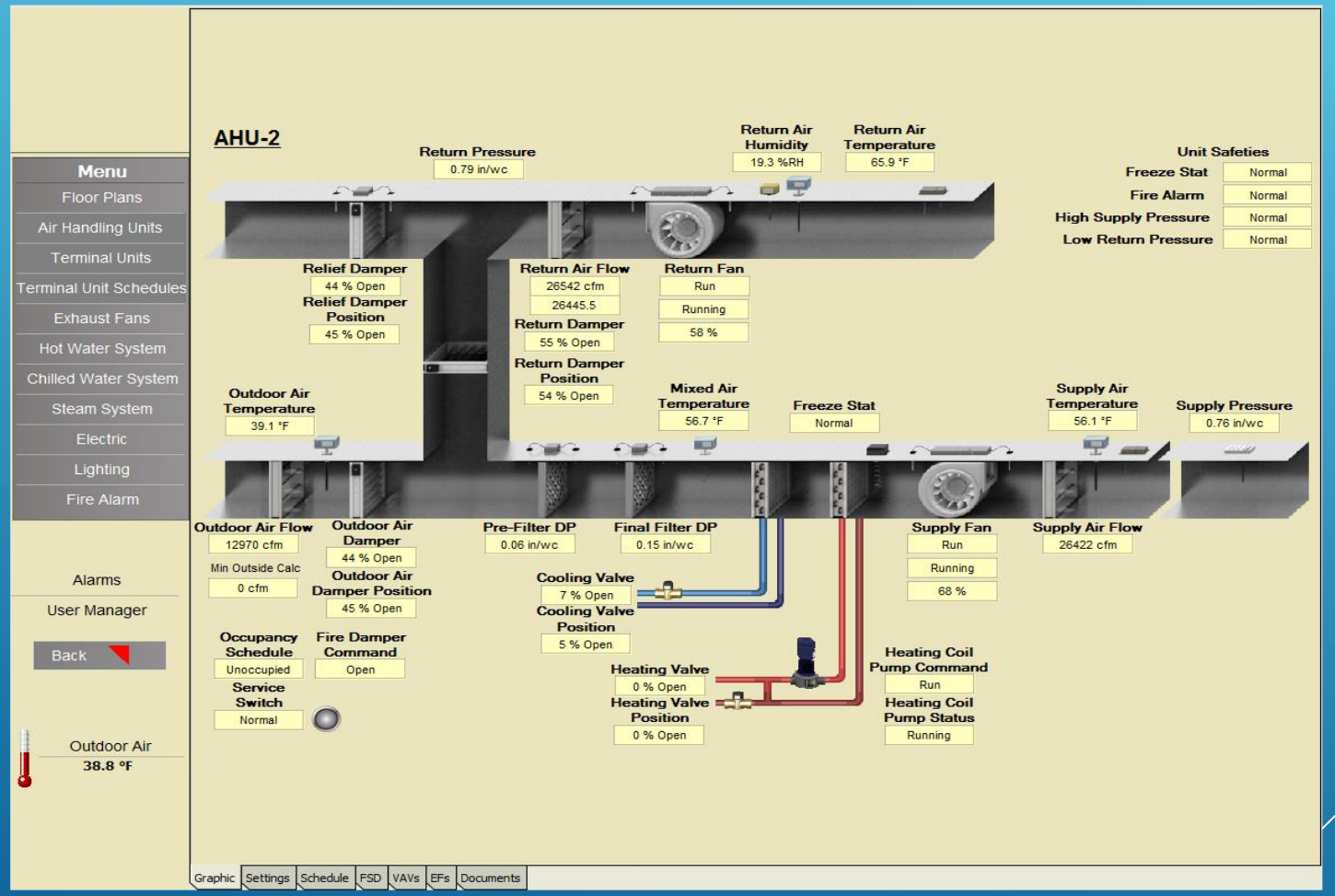
Electrical Data

Motor Manufacturers Information

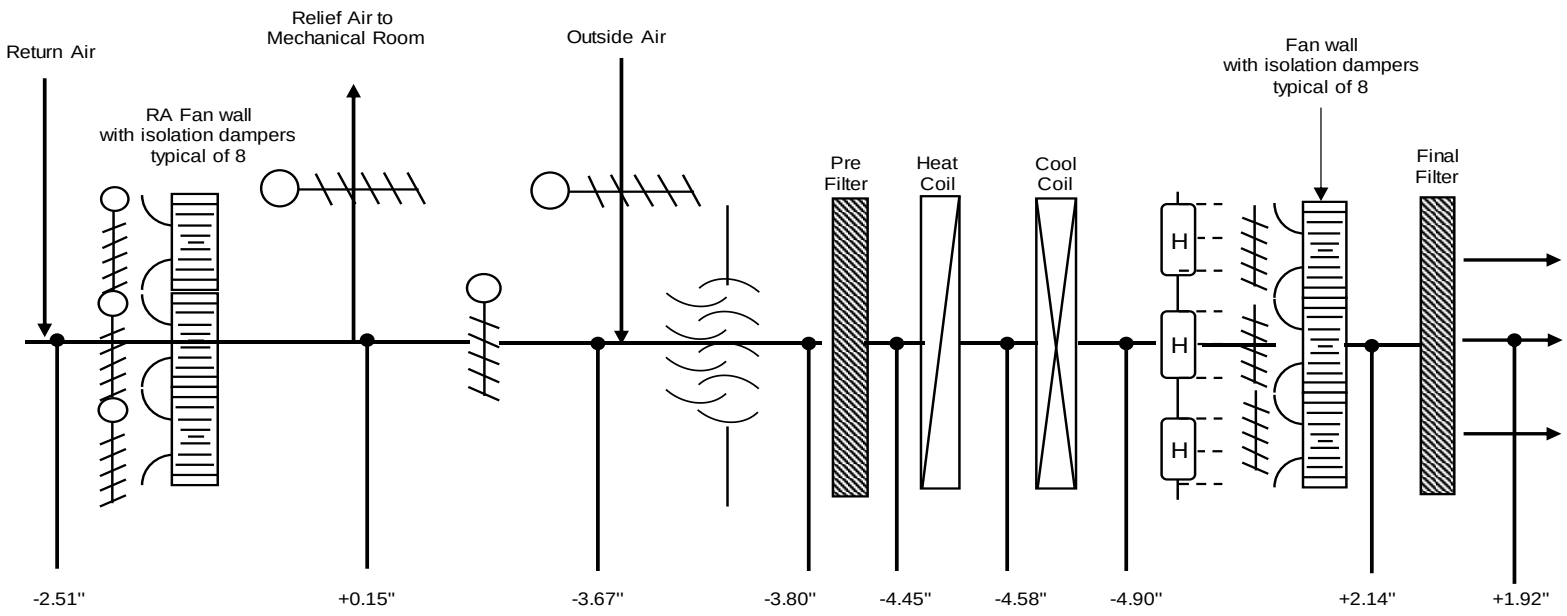
Roof top unit component pressure drops

Roof Top Unit Schematic

BUILT UP AIR HANDLING UNIT SCHEMATIC



COMPONENT PRESSURE DROPS (BUILT UP AIR HANDLING UNIT)



Component Pressure Drops

Blender:	0.13"
Pre Filter:	0.65"
Heating Coil:	0.13"
Cooling Coil:	0.32"
Final Filter:	0.22"
Humidifier:	~

Fan Total Static Pressures

Supply Fan		**Return Fan**	
Discharge Static:	+2.14"	Discharge Static:	+0.15"
Suction Static:	-4.90"	Suction Static:	-2.51"
Total Static Press:	7.04"	Total Static Press:	2.66"

Building:	DMC Childrens Hospital Critical Care Tower	Index :	1
		Page :	2
System:	AHU-1	Date :	4/22/17

INFORMATION REQUIRED FOR A DUCT TRAVERSE TEST REPORT

- a) System Designation Design
- b) Unit Designation Design
- c) Reading Location Actual
- d) Reading Designation (Unique ID/mode) Actual
- e) Instrument Used Actual
- f) CFM Design & Actual
- g) Dimension of Traversed Area Actual
- h) Sq. Ft. of Traversed Area1 Actual
- i) Cross Section Sketch Actual
- j) Velocity Readings in Grid Form Actual
- k) Average Velocity Actual
- l) Centerline Duct SP Actual
- m) Air Temperature Actual
- 1 Include effective area multiplier if opening is equipped with a screen, expanded metal, etc.

DUCT TRAVERSE PITOT TUBE SPACING

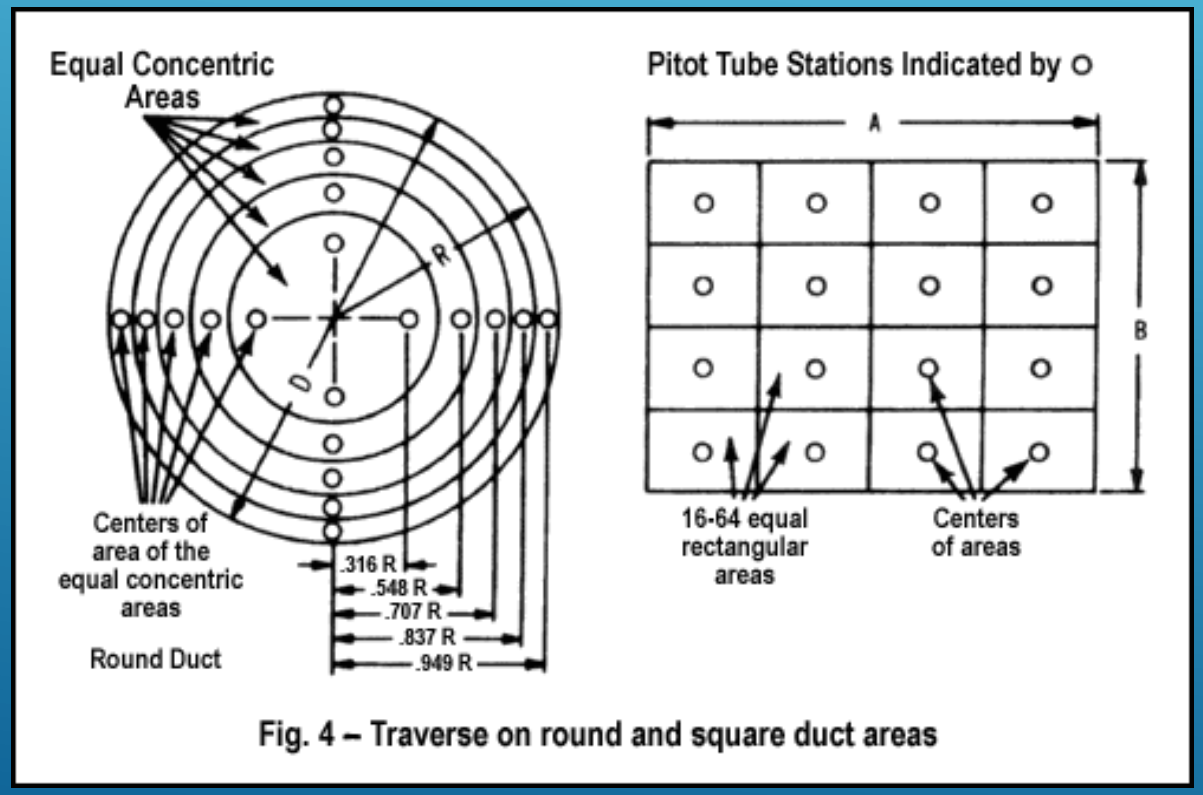
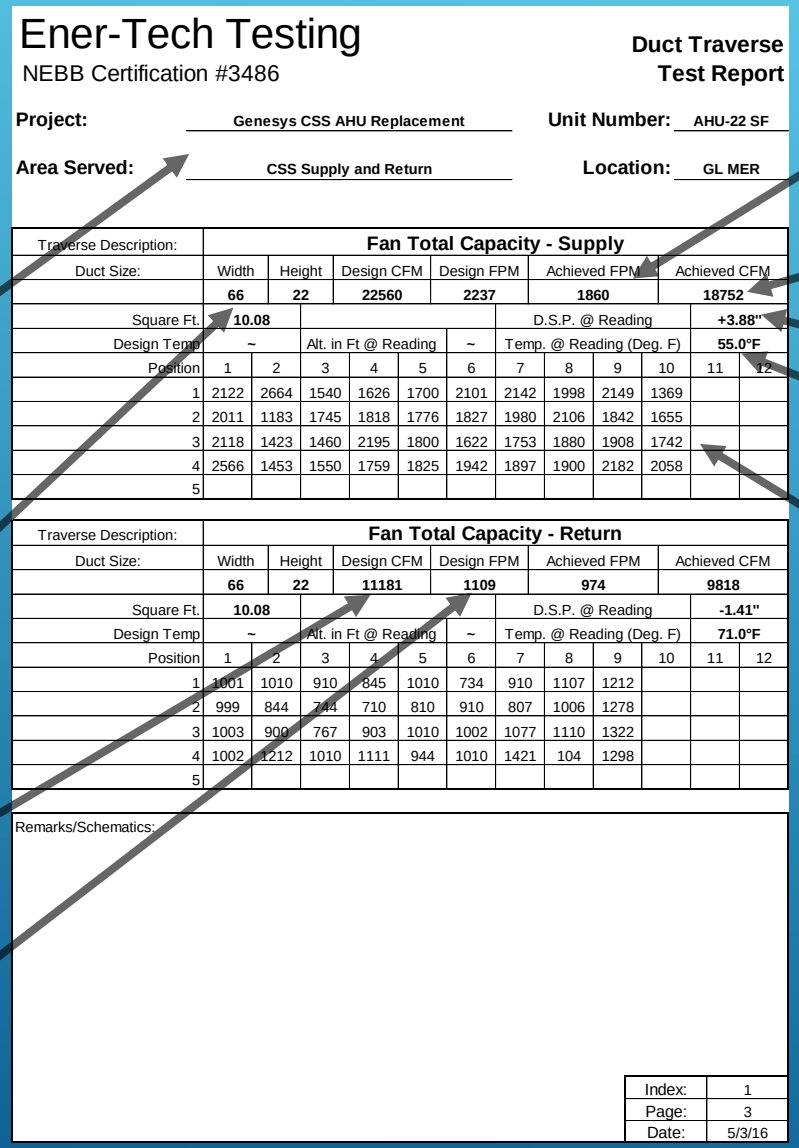


Fig. 4 – Traverse on round and square duct areas

DUCT TRAVERSE TEST REPORT



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Duct Traverse Test Report

Project: Genesys CSS AHU Replacement

Unit Number: AHU-22 SF

Area Served: CSS Supply and Return

Location: GL MER

Traverse Description:	Fan Total Capacity - Supply											
Duct Size:	Width	Height	Design CFM	Design FPM	Achieved FPM	Achieved CFM						
	66	22	22560	2237	1860	18752						
Square Ft.	10.08				D.S.P. @ Reading						+3.88"	
Design Temp	~		Alt. in Ft @ Reading		~		Temp. @ Reading (Deg. F)				55.0°F	
Position	1	2	3	4	5	6	7	8	9	10	11	12
1	2122	2664	1540	1626	1700	2101	2142	1998	2149	1369		
2	2011	1183	1745	1818	1776	1827	1980	2106	1842	1655		
3	2118	1423	1460	2195	1800	1622	1753	1880	1908	1742		
4	2566	1453	1550	1759	1825	1942	1897	1900	2182	2058		
5												

Traverse Description:	Fan Total Capacity - Return											
Duct Size:	Width	Height	Design CFM	Design FPM	Achieved FPM	Achieved CFM						
	66	22	11181	1109	974	9818						
Square Ft.	10.08				D.S.P. @ Reading						-1.41"	
Design Temp	~		Alt. in Ft @ Reading		~		Temp. @ Reading (Deg. F)				71.0°F	
Position	1	2	3	4	5	6	7	8	9	10	11	12
1	1001	1010	910	845	1010	734	910	1107	1212			
2	999	844	744	710	810	910	807	1006	1278			
3	1003	900	767	903	1010	1002	1077	1110	1322			
4	1002	1212	1010	1111	944	1010	1421	104	1298			
5												

Remarks/Schematics:

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Project, Area Served, Unit Number, Location

Duct dimension and square footage

Design CFM

Design FPM CFM / Area

Average Actual Velocity

Actual CFM Velocity X Area

Duct Static Pressure at Reading

Temperature at Reading

Actual Velocity Measurements

INFORMATION REQUIRED ON AN AIR OUTLET/INLET TEST REPORT

- a) System Designation Design
- b) System Sketch Actual
- c) Area Served Actual
- d) Outlet/Inlet Designation Actual
- e) Outlet/Inlet & Total Design CFM Design
- f) Outlet/Inlet & Total Preliminary CFM Actual
- g) Outlet/Inlet & Total Final CFM Actual
- h) Outlet/Inlet Size where Ak ≠ 1.0 Actual
- i) Outlet/Inlet Area where Ak ≠ 1.0 Actual
- j) Ak Where Effective Area ≠ 1.0 Actual
- k) Velocity Where Ak ≠ 1.0 Actual

AIR OUTLET/INLET TEST REPORT

Ener-Tech Testing

NEBB Certification #3486

Outlet/Inlet Test Report

Project: Security Credit Union Operations Building **Unit Number:** RTU-2

Area Served: First Floor Offices & Lending Supply **Location:** Roof

Area Served	Outlet/Inlet NO.	Size/Type	AK	Design CFM	Design VEL	Test Data 1st	Test Data 2nd	Test Data 3rd	Test Results VEL	Test Results DP	Test Results CFM
		Supply Air Data									
AVP Lending LP 111	1	8"Ø Nk Lin	FH	270		282	285				285
AVP Lending LP 111	2	8"Ø Nk Lin	FH	270		244	256				256
	5	VB-9-2	Max	540		Damper Position Maximum				70%	541
		8"Ø Inlet	Min	200		Damper Position Minimum				35%	198
Corridor	1	8"Ø Nk Diff	FH	120		132	112	129			129
Future Use 133	2	8"Ø Nk Diff	FH	170		117	144	171			171
Future Use 133	3	8"Ø Nk Diff	FH	170		154	150	171			171
Mechanical Room 132	4	8"Ø Nk Diff	0.350	120	343	445	123	348	348		122
	6	VB-4-2	Max	580		Damper Position Maximum				75%	593
		8"Ø Inlet	Min	175		Damper Position Minimum				40%	175
Cubicles 119	1	8"Ø Nk Diff	FH	135		130	132	137			137
Corridor	2	8"Ø Nk Diff	FH	120		190	135	121			121
Cubicles 119	3	8"Ø Nk Diff	FH	135		87	136	135			135
	7	VB-3-2	Max	390		Damper Position Maximum				62%	393
		8"Ø Inlet	Min	105		Damper Position Minimum				35%	107
Lending Support Sup. 124	1	10"Ø Nk Lin	FH	380		279	331	375			375
Oper. Support Office 125	2	8"Ø Nk Lin	FH	200		286	203	211			211
	8	VB-2-2	Max	580		Damper Position Maximum				60%	586
		8"Ø Inlet	Min	200		Damper Position Minimum				30%	204
Corridor	1	8"Ø Nk Diff	FH	120		179	123				123
Indirect Lending Rel. 123	2	6"Ø Nk Diff	FH	80		95	83				83
Maintenance 134	3	8"x12" Grille	0.350	110	314	248	318		318		111
Comm. Services Spec. 122	4	6"Ø Nk Diff	FH	80		93	82				82
	9	VB-1-2	Max	390		Damper Position Maximum				100%	399
		8"Ø Inlet	Min	115		Damper Position Minimum				50%	117
	Air Terminal Unit Maximum Capacity			6210			Achieved Maximum Capacity:				6016

Remarks/Schematics:

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Project, Area Served, Unit Number, Location

Room Served

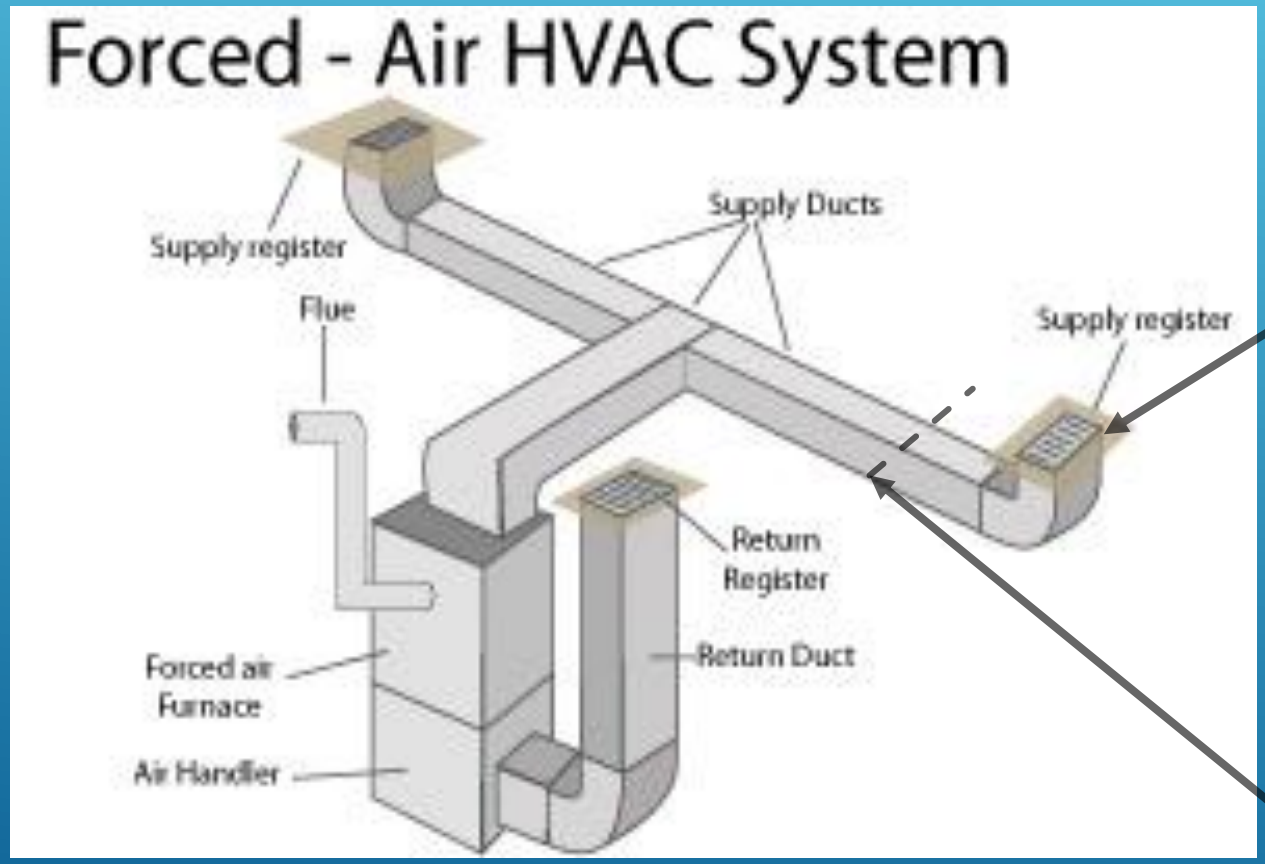
Diffuser Neck Size

FH (Abbreviation for Flow Hood)

Unable to use Flow Hood, Duct Traverse Performed CFM=Velocity X Area

Ak developed for this outlet

AK DEVELOPMENT (AIR COEFFICIENT) FOR REGISTERS AND GRILLE



STEP 2: Velocity measured using the appropriate instrument (Shortridge Velgrid or Airfoil, Rotating Vane Anemometer)

STEP 3: Calculate the Ak of the register or grille
CFM / Velocity = Ak

STEP 1: Duct traverse performed in the duct for actual CFM to the outlet

AIR TERMINAL UNIT REQUIRED INFORMATION

- a) Maximum Cooling Airflow Design & Actual
- b) Minimum Cooling Airflow Design & Actual
- c) Heating Maximum Airflow Design & Actual
- d) Heating Minimum Airflow Design & Actual
- e) Controller Address Actual
- f) Controller Calibration Factor Actual

VARIABLE AIR VOLUME BOX (AIR TERMINAL UNIT)

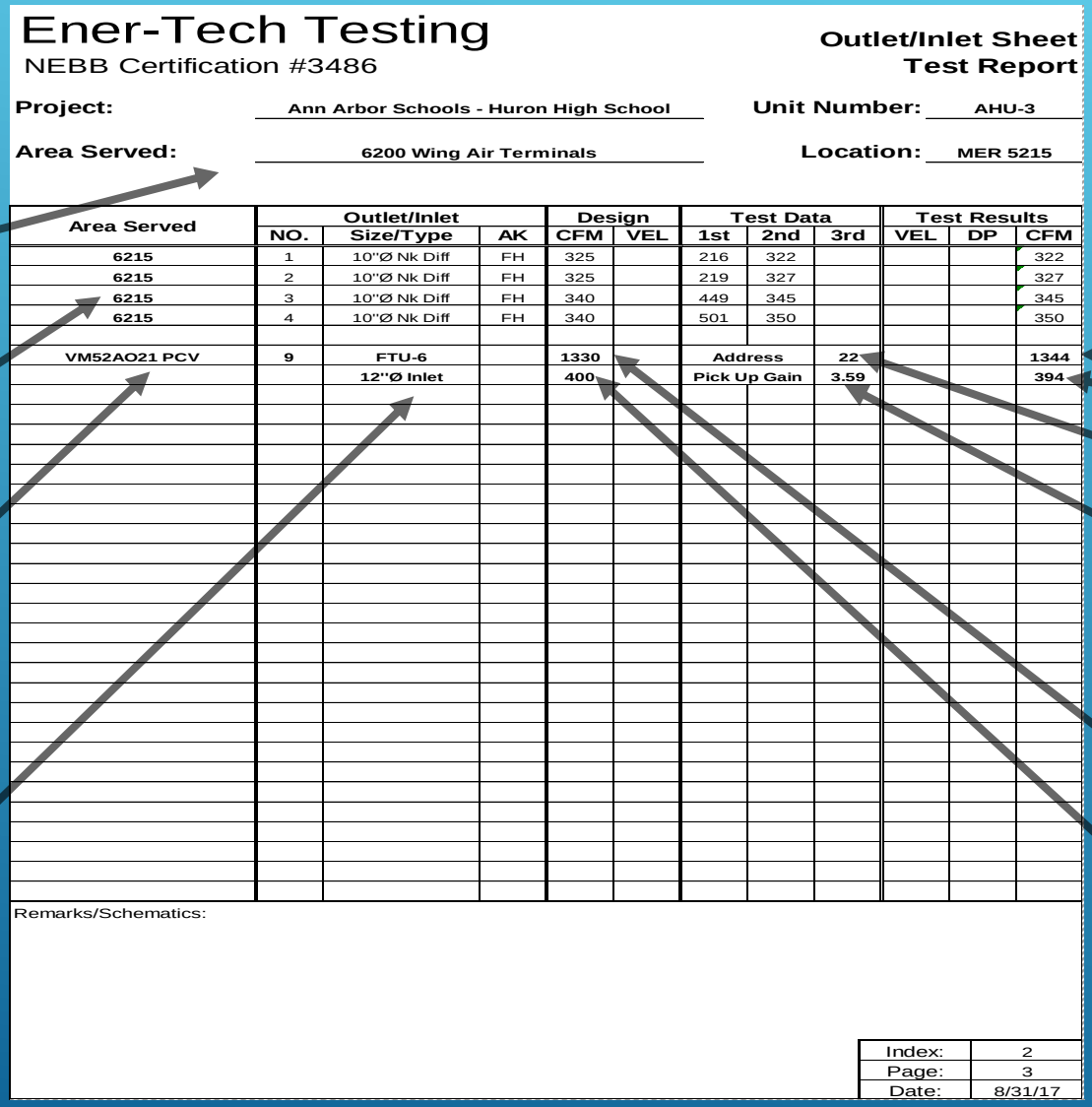
Inlet Sensor

Inlet Duct

Velocity Controller

Differential Pressure Test Ports

AIR TERMINAL UNIT TEST REPORT



Ener-Tech Testing

NEBB Certification #3486

Outlet/Inlet Sheet
Test Report

Project: Ann Arbor Schools - Huron High School **Unit Number:** AHU-3

Area Served: 6200 Wing Air Terminals **Location:** MER 5215

Area Served	Outlet/Inlet			Design		Test Data			Test Results		
	NO.	Size/Type	AK	CFM	VEL	1st	2nd	3rd	VEL	DP	CFM
6215	1	10"Ø Nk Diff	FH	325		216	322				322
6215	2	10"Ø Nk Diff	FH	325		219	327				327
6215	3	10"Ø Nk Diff	FH	340		449	345				345
6215	4	10"Ø Nk Diff	FH	340		501	350				350
VM52AO21 PCV	9	FTU-6		1330		Address		22			1344
		12"Ø Inlet		400		Pick Up Gain		3.59			394

Remarks/Schematics:

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Project, Area Served, Unit Number, Location

Room Served

Air Terminal Unit Device BMS Designation

Mechanical Drawing Air Terminal Designation

Achieved Maximum CFM

Achieved Minimum CFM

BMS Address Number

BMS Address Number

Maximum Cooling CFM Design

Minimum Cooling/Heating CFM Design

AIR APPARATUS COMBINATION REPORT

Ener-Tech Testing

NEBB Certification #3486

Air Apparatus Test Report

Project: Security Credit Union Operations Building **Unit Number:** EF-1

Area Served: 1st & 2nd Floor Main Restroom Exhaust **Location:** Roof

Fan / Unit Data		
Make	Cook	
Model	135ACE	
Type / Size	~	~
Class/Arrangement	~	~
Serial Number	129SG78077-701	
Discharge	Downblast	
Fan Drive Information		
Sheave Diameter	MA35	
Shaft Size(Bushing)	3/4"	
No. Belts/Size	1	4L210

Motor Data			
Manufacturer	Marathon		
H.P. / Amps	0.33		5.5
Ph./Hertz/Volts	1	60	120
Frame / RPM	48Y		1725
Ser. Factor/P. F.	1.35		~
Efficiency:	~		
Motor Drive Information			
Sheave Diameter	MVL34 at Mid		
Shaft Size (Bushing)	1/2"		
CL to CL Distance	5-3/4"		
Motor Adjustment	+ 1"		- 2"

Test Data	Design	Actual
Total CFM	1350	1372
Return Air CFM	~	~
Minimum OA CFM	~	~
Total S.P.	~	~
External S.P.	0.75"	0.90"
Fan RPM	1560	1308
Brake Horsepower	~	0.33

Electrical Test Data			
Motor Amps T1 T2 T3	~	5.44	~
Motor Volts T1 T2 T3	~	121	~
V.F.D. Setting	~		
Motor Frequency	60Hz		
Thermal Overloads	Thermally Protected		

Test Data	Design	Actual
Fan Discharge S.P.	~	ATM
Fan Suction S.P.	~	-0.90"
External S.P.	~	0.90"
Component Pressure Drops		
Filter:	~	~
Coil:	~	~
HTX:	~	~
Test Conditions		
Return Air Damper	~	~
Outside Air Damper	~	~
Relief Air Damper	~	~

Area Served	Outlet/Inlet			Design		Test Data			Test Results		
	NO.	Size/Type	AK	CFM	VEL	1st	2nd	3rd	VEL	DP	CFM
Women 209	1	10"x10" Reg	1.100	150	136	216	135		135		149
Women 209	2	10"x10" Reg	1.100	150	136	295	140		140		154
Janitor 210	3	10"x10" Reg	0.470	75	160	189	160		160		75
Janitor 117	4	6"Ø Open Duct	0.196	75	383	585	390		390		76
Women 116	5	10"x10" Reg	1.100	150	136	86	140		140		154
Women 116	6	10"x10" Reg	1.100	150	136	67	141		141		155
Men 118	7	10"x10" Reg	1.100	150	136	126	140		140		154
Men 118	8	10"x10" Reg	1.100	150	136	88	135		135		149
Men 211	9	10"x10" Reg	1.100	150	136	153	140		140		154
Men 211	10	10"x10" Reg	1.100	150	136	162	138		138		152
	Design Capacity			1350			Achieved Capacity				1372

Remarks/Schematics:

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Project, Area Served, Unit Number, Location

Fan Manufacturers Information

Fan Drive Data

Inlet/Outlet Area Served

Motor Manufacturers Information

Motor Drive Data

Fan Static Pressures

Inlet / Outlet Test Data

LABORATORY FUME HOOD FACE VELOCITY FORM

Laboratory Fume Hood Face Velocity Form

Project Name:	Axalta Mt Clemens - R&D Building 2017 Yearly Testing
Lab Number:	Lab 7

100 FPM Face Velocity Sash Height						
Lab Number	**7**	Face Velocities				
Fan Number	**HD 3 Ex**	110	100	88	73	
Sash Width (Inch)	49	80	86	82	78	
Sash Height (Inch)	30					
Sash Open Area	10.21					
Average FPM	**87**					
Calculated CFM	889					

100 FPM Face Velocity Sash Height						
Lab Number	**7**	Face Velocities				
Fan Number	**HD 4 Ex**	75	89	97	105	
Sash Width (Inch)	49	82	87	92	57	
Sash Height (Inch)	30					
Sash Open Area	10.21					
Average FPM	**86**					
Calculated CFM	873					

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Project, Lab Number

Lab/Room Number

Fan Number

Hood Sash Size

Average Velocity of Readings

Achieved CFM (Velocity X Area)

Measured velocities at the sash opening

LABORATORY FUME HOOD

Sash Opening
Measured with a Velgrid
Typically fume hood sash stops @ 18”

AIR CHANGE REPORT

Room Size in Cubic Volume

Design Room Offset (Supply – Return)

Air Systems Involved

Achieved Room Offset (Supply – Return)

Achieved Air Changes (CFM X 60 / Room Cubic Volume)

Design CFM

Room Pressure (Doors Closed)

Room Tested

Project, Area Served, Unit Number

Achieved CFM

Ventilation Information

Supply System: RTU-1 **Return System:** RTU-1 **Exhaust System:** Existing

Room No. or Location	Design Data			Test Data						Comments:
	Supply CFM	Exhaust CFM	Diff	Room Volume in Cubic Feet	Supply CFM	Exhaust CFM	Diff	Room Pressure	Air Changes / Hour	
OR-1	**1560**	**1360**	**200**	**4364**	**1570**	**1350**	**220**	**+0.020"**	**21.6**	
OR-2	**1450**	**1150**	**300**	**4020**	**1446**	**1154**	**292**	**+0.014"**	**21.6**	OR-2 has (2) doors
OR-3	**1560**	**1360**	**200**	**4370**	**1576**	**1355**	**221**	**+0.017"**	**21.6**	
OR-4	**1560**	**1360**	**200**	**4198**	**1561**	**1355**	**206**	**+0.017"**	**22.3**	
Clean Utility Clean Storage	**524**	**475**	**49**	**3142**	**614**	**554**	**60**	**+0.002"**	**11.7**	
Soiled Utility	**None**	**73**	**73**	**728**	**None**	**99**	**99**	**-0.002"**	**8.2**	

Building: Tru-Vista Surgery Center - Operating Room Area Air Changes

Area/System : Operating Room Supply RTU-1

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REQUIRED INFORMATION PUMP TEST REPORT

- a) Flow Rate Design & Actual
- b) Impeller Installed
- c) Pump Off Pressure Actual
- d) RPM Design & Actual
- SHUTOFF:
- a) Suction Pressure Actual
- b) Discharge Pressure Actual
- c) Total Dynamic Head Design & Actual
- FINAL SETTING:
- a) Suction Pressure Actual
- b) Discharge Pressure Actual
- c) Total Dynamic Head Design & Actual

PUMP TEST REPORT

Project, System Served, Pump Number, Location

Pump Manufacturer Information

Actual impeller diameter proven by head pressure readings

Electrical Test Data

Ener-Tech Testing

NEBB Certification #3486

Pump Test Report

Project: Midland Schools - STEM Elementary

Pump Number: CP-10 & CP-11

System Served: Secondary Hot Water Heating

Location: MER D119

Name Plate Data	Pump Number: CP-10			Pump Number: CP-11		
Location	MER-D119			MER-D119		
Service	Secondary Hot Water Heating			Secondary Hot Water Heating		
Manufacturer	B&G			B&G		
Model Number	e-1510 2.5BB			e-1510 2.5BB		
Serial Number	C2244805-02E61			C2244805-02E61		
Design GPM / TDH	250.0	55.0'		250.0	55.0'	
Required NPSH	~			~		
Pump RPM	1750			1750		
Impeller Diameter	8.125"			8.125"		
Motor Manufacturer	Baldor			Baldor		
Motor HP/Full Load A	7.5	9.7		7.5	9.7	
Phase/HZ/Volts	3	60	460	3	60	460
Frame/RPM	213T	1770		213T	1770	
S.F./P.F./EFF.	1.15	79	91	1.15	79	91
Overload Size	Protected Through VFD			Protected Through VFD		

	Testing Data			Testing Data		
Static Head Pressure:						
	Discharge	Suction	TDH	Discharge	Suction	TDH
Oper. Head Press:	90.3'	39.5'	50.8'	91.2'	40.6'	50.6'
Shut Off Head Press:	122.8'	57.2'	65.6'	123.2'	57.2'	66.0'
Actual Impeller Dia.	8.125"			8.125"		
Final GPM	275.0			275.0		

	Electrical Test Data			Electrical Test Data		
Amperage: T_1 T_2 T_3		7.7			7.7	
Voltage: T_1 T_2 T_3		460			460	
Calculated BHP	6.0			6.0		

Remarks/Schematics:
Current Element Capacity: 347.20
Loop Diiferential Setpoint: 11 PSI

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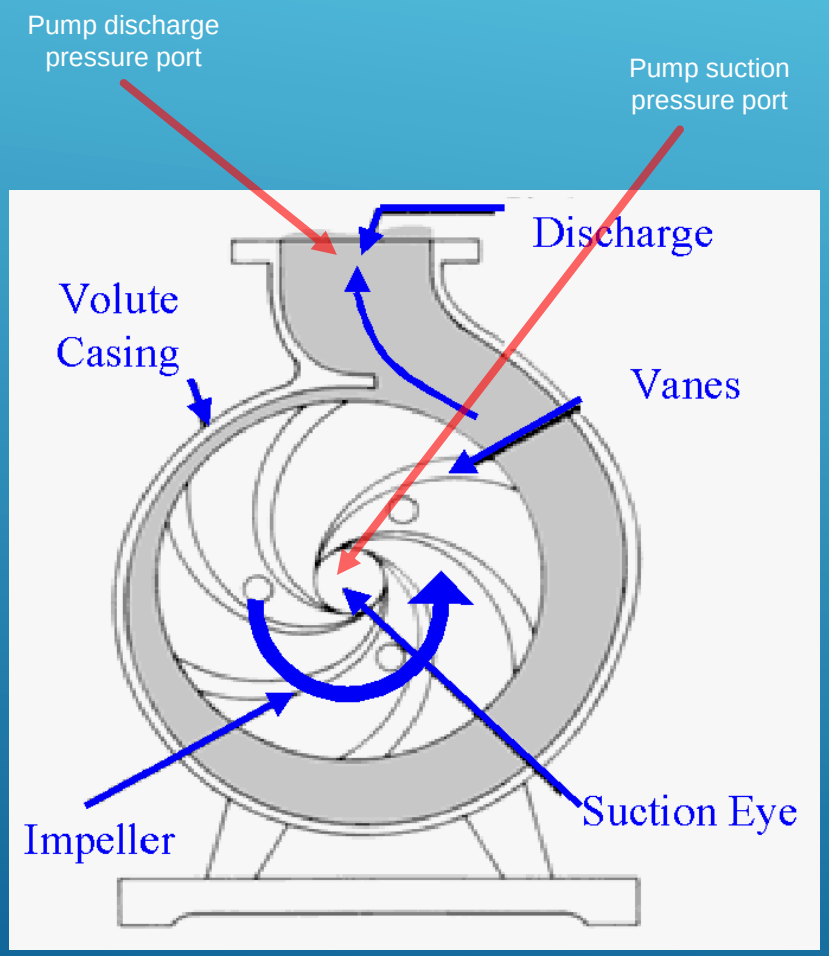
Design Flow Rate (GPM and TDH)

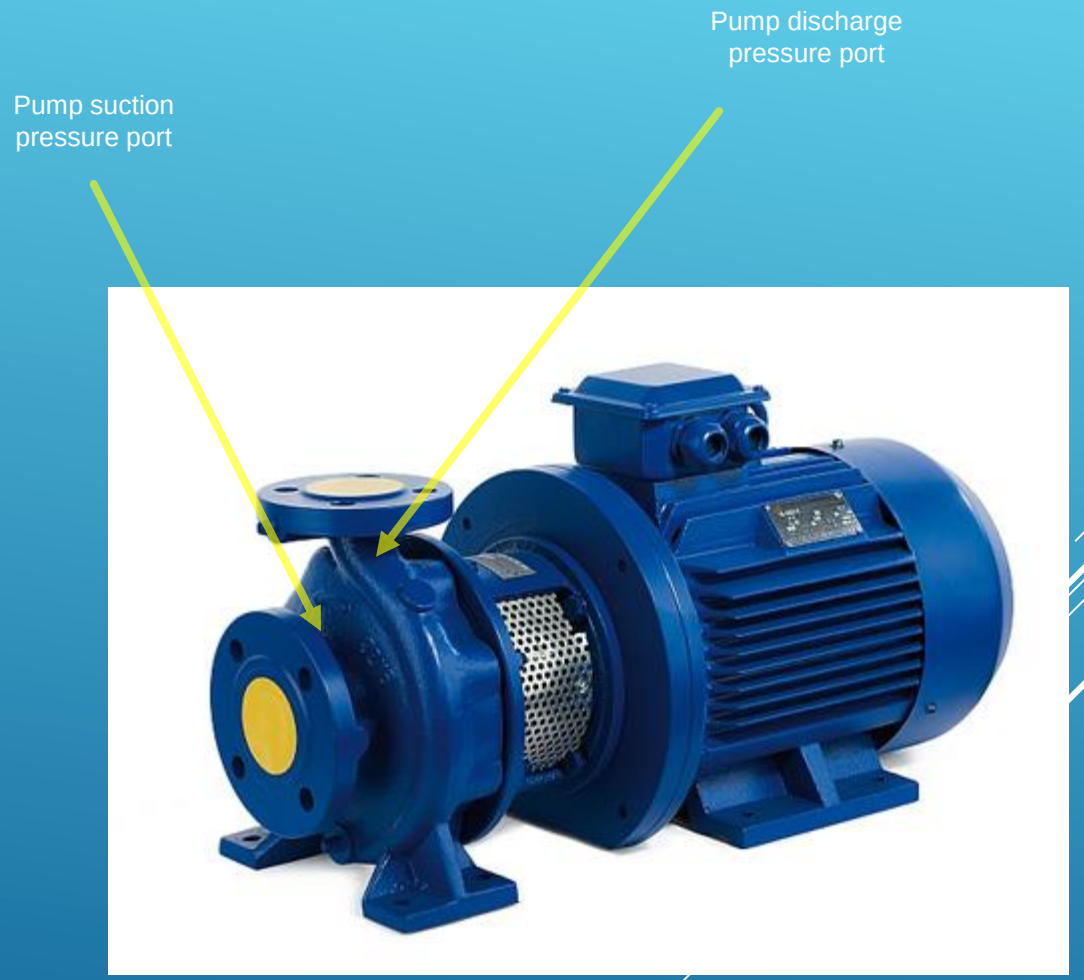
Motor Manufacturer Information

Pump head pressure readings

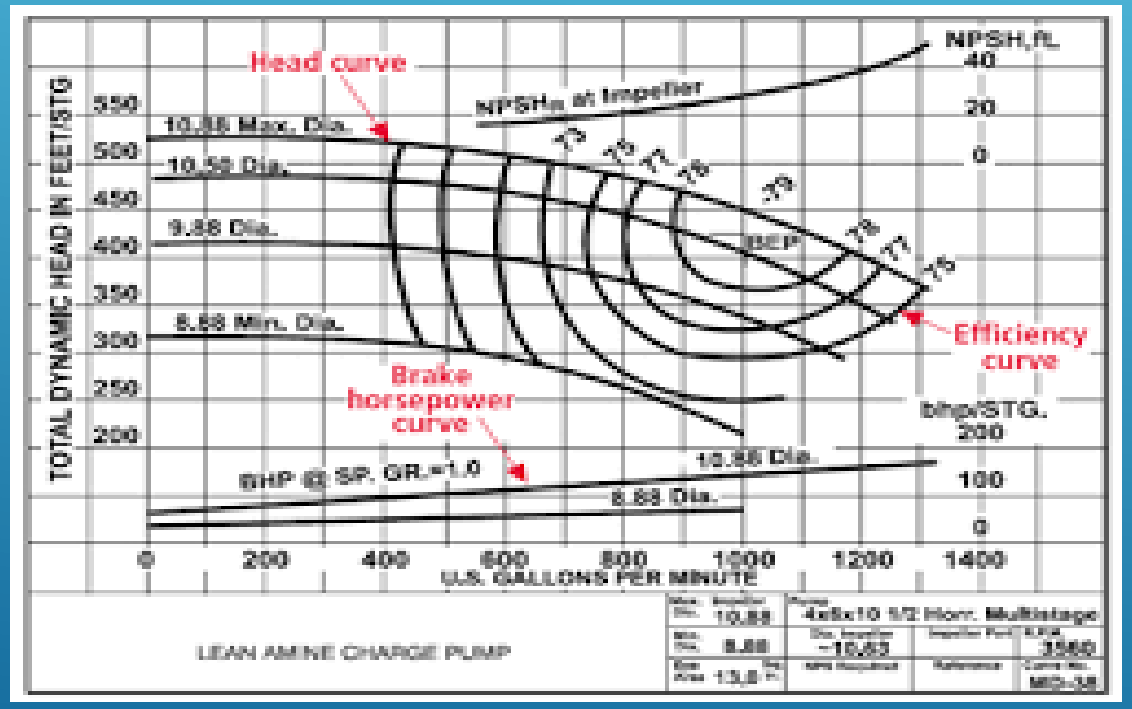
Actual GPM determined by pump curve or total system flow meter

CENTRIFUGAL PUMP

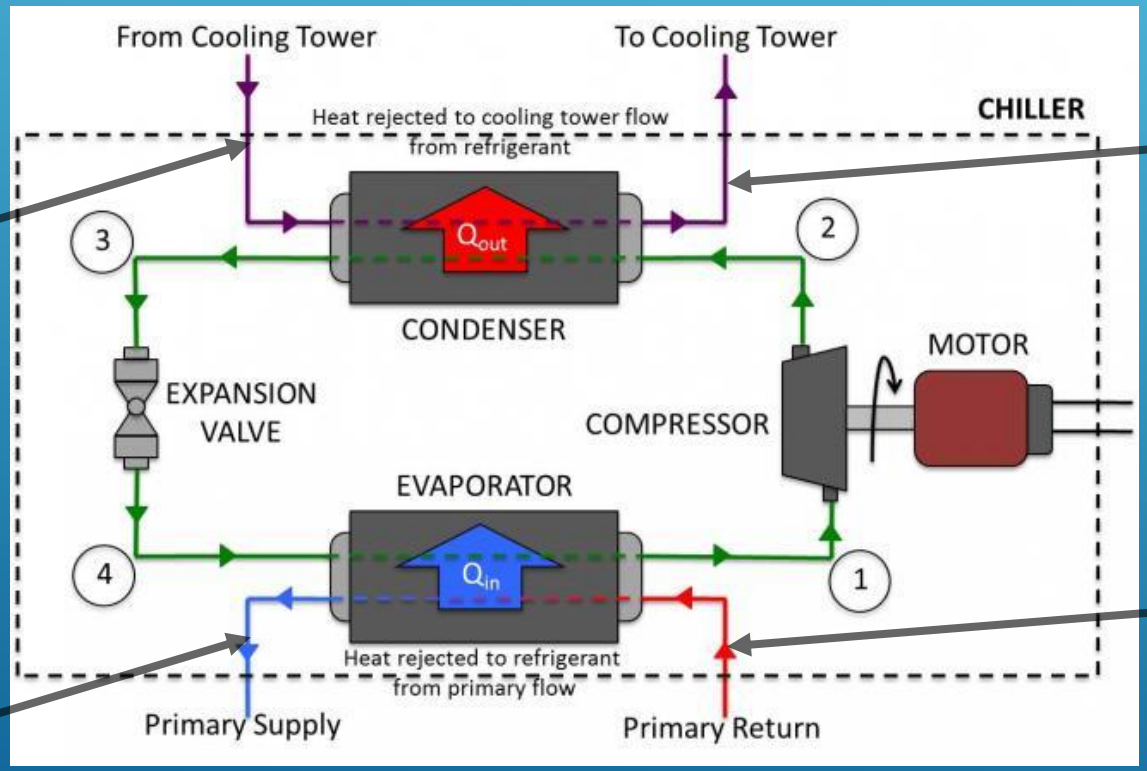




TYPICAL PUMP CURVE



CHILLER SYSTEM TEST LOCATIONS



Condenser inlet pressure

Condenser outlet pressure

Evaporator Inlet Pressure

Evaporator outlet pressure

CHILLER PRESSURE DROP TEST

Project name, system served, pump number, location

Chiller name and test configuration

Design GPM

Design pressure drop

Inlet and outlet pressure

Ener-Tech Testing

NEBB Certification # 3486

Hydronic Element Test Report

Project: DMC Childrens Hospital Critical Care Tower **Pump Number:** CP-1A, 1B & 1C

System Served: Primary Chilled Water Supply **Location:** Penthouse

Loc	Elem. Type/Des.	ID No	Design Data GPM	Flow Meter	Size	Bal. Valve Press. Drop	Preliminary Test Data #1	#2	#3	Test Results Press. Drop	Valve Setting	IND. GPM
							Ent	Lvg		DP		
Chiller Pressure Drop CH-1:			1096.20	Chiller Pressure Drop		9.2'	90.8'	81.2'		9.6'	~	1120
Pump CP-1A Running												
Chiller Pressure Drop CH-2:			1096.20	Chiller Pressure Drop		9.2'	91.7'	82.3'		9.4'	~	1108
Pump CP-1B Running												
Chiller Pressure Drop CH-2:			1096.20	Chiller Pressure Drop		9.2'	92.2'	82.9'		9.3'	~	1102
Pump CP-1C Running												

Remarks/Schematics:

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Ener-Tech Testing

NEBB Certification # 3486

Hydronic Element Test Report

Project: DMC Childrens Hospital Critical Care Tower **Pump Number:** CP-2A, 2B & 2C

System Served: Condenser Water Supply **Location:** Penthouse

Loc	Elem. Type/Des.	ID No	Design Data GPM	Flow Meter	Size	Bal. Valve Press. Drop	Preliminary Test Data ENT	LVG	#3	Test Results Press. Drop	Valve Setting	IND. GPM
Chiller Pressure Drop CH-1			1650.0	Chiller Pressure Drop		6.8'	49.2'	42.0'		7.2'	~	1697.8
CP-2A On												
Chiller Pressure Drop CH-2			1650.0	Chiller Pressure Drop		6.8'	50.5'	43.5'		7.0'	~	1674.1
CP-2B On												
Chiller Pressure Drop CH-2			1650.0	Chiller Pressure Drop		6.8'	49.8'	42.7'		7.1'	~	1686.0
CP-2C On												

Remarks/Schematics:

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Actual chiller pressure drop

Achieved GPM

BOILER WITH BOILER CIRCULATION AND SECONDARY PUMPS

Boiler Circulation Pumps

Secondary Heating Pumps

BOILER CIRCULATION TEST REPORT

Project name, system served, pump number, location

Boiler Number

Design GPM

Balance valve type and size

Balance valve final pressure drop, valve setting, actual GPM

Ener-Tech Testing

NEBB Certification # 3486

Hydronic Element Test Report

Project: AT&T Saginaw Boiler Replacement Phase 3 **Pump Number:** HHWP-1,2,3

System Served: Hot Water Heating **Pump Location:** Basement

Loc	Elem. Type/Des.	ID No	Design Data				Preliminary Test Data			Test Results		
			GPM	Flow Meter	Size	Bal. Valve Press. Drop	#1	#2	#3	Press. Drop	Valve Setting	IND. GPM
			HHWP-1 Online									
Boiler Room	Boiler 1		176.0	B & G	4.0"	~	3.2'			3.2'	10.0°	188.0
Boiler Room	Boiler 2		176.0	B & G	4.0"	~	3.3'			3.3'	10.0°	189.0
Boiler Room	Boiler 3		~	B & G	4.0"	~	Valved off					
								HHWP-1 Total Capacity:				377.0
			HHWP-2 Online									
Boiler Room	Boiler 1		176.0	B & G	4.0"	~	3.0'			3.0'	10.0°	182.0
Boiler Room	Boiler 2		176.0	B & G	4.0"	~	3.1'			3.1'	10.0°	183.0
Boiler Room	Boiler 3		~	B & G	4.0"	~	Valved off					
								HHWP-2 Total Capacity:				365.0
			HHWP-3 Online									
Boiler Room	Boiler 1		~	B & G	4.0"	~	Valved off					
Boiler Room	Boiler 2		132.0	B & G	4.0"	~	1.6'			1.6'	10.0°	135.0
Boiler Room	Boiler 3		132.0	B & G	4.0"	~	1.6'			1.6'	10.0°	135.0
								HHWP-3 Total Capacity:				270.0

Remarks/Schematics:

Testing procedure:
Because the total volume of HHWP-1, 2 and 3 passes thrugh Boiler 1, 2 and 3 and had calibrated flow meters attached to them, the boilers were used as a flow measuring devices.
Boiler 1 and 2 were open to the system and Boiler 3 was valved off. We then measured the flow thru the boilers at the two remaining flow meters. We rotated the isolated boiler to prove consistent flow through the boilers.

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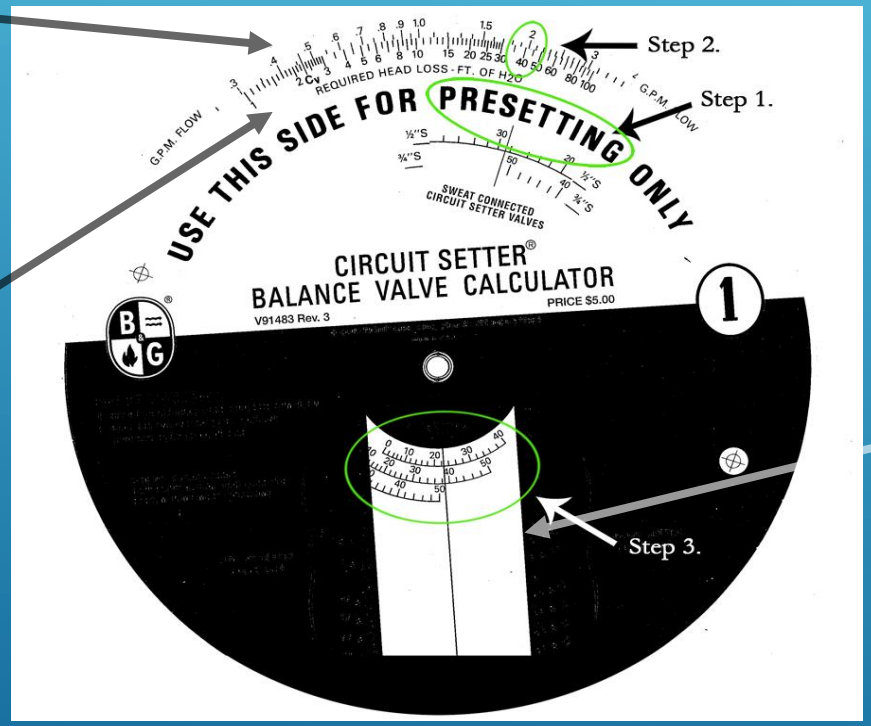
VARIABLE OPENING BALANCE VALVE

VARIABLE OPENING VALVE FLOW CALCULATOR

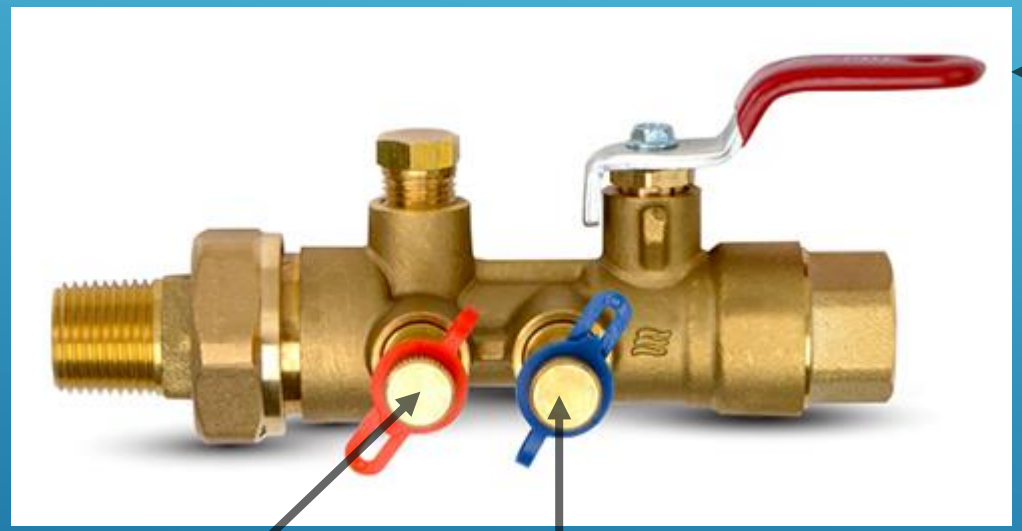
Flow rate in GPM

Head loss in feet of head



Valve position and valve size

FIXED OPENING BALANCE VALVE

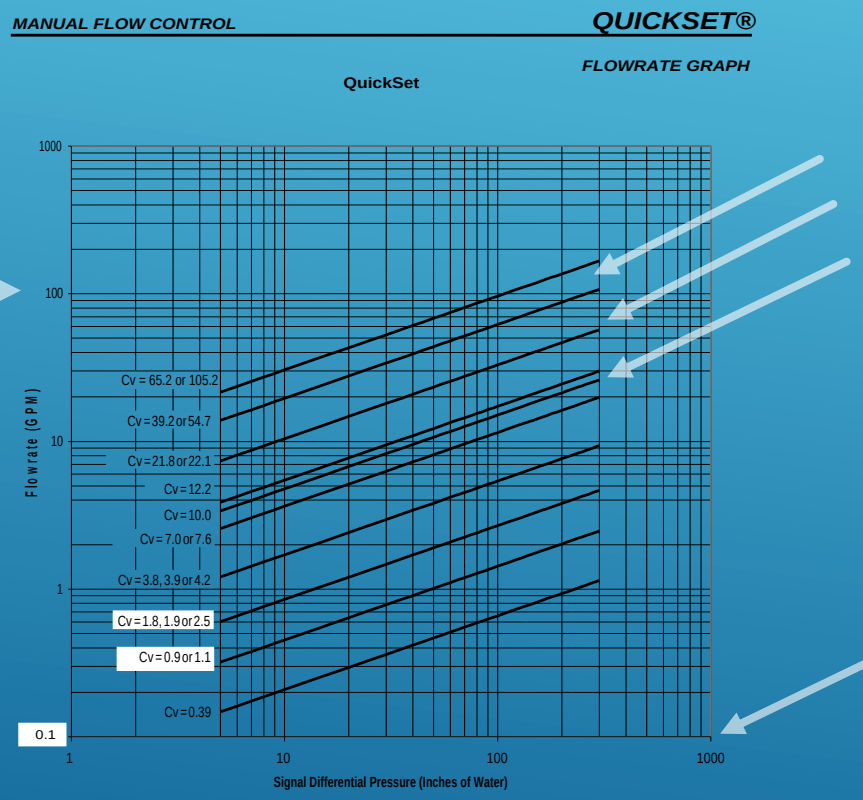


Valve handle with memory stop

Valve inlet pressure

Valve outlet pressure

VENTURI TYPE FIXED OPENING BALANCE VALVE CHART



Flowrate in GPM

Various valve sizes on one chart

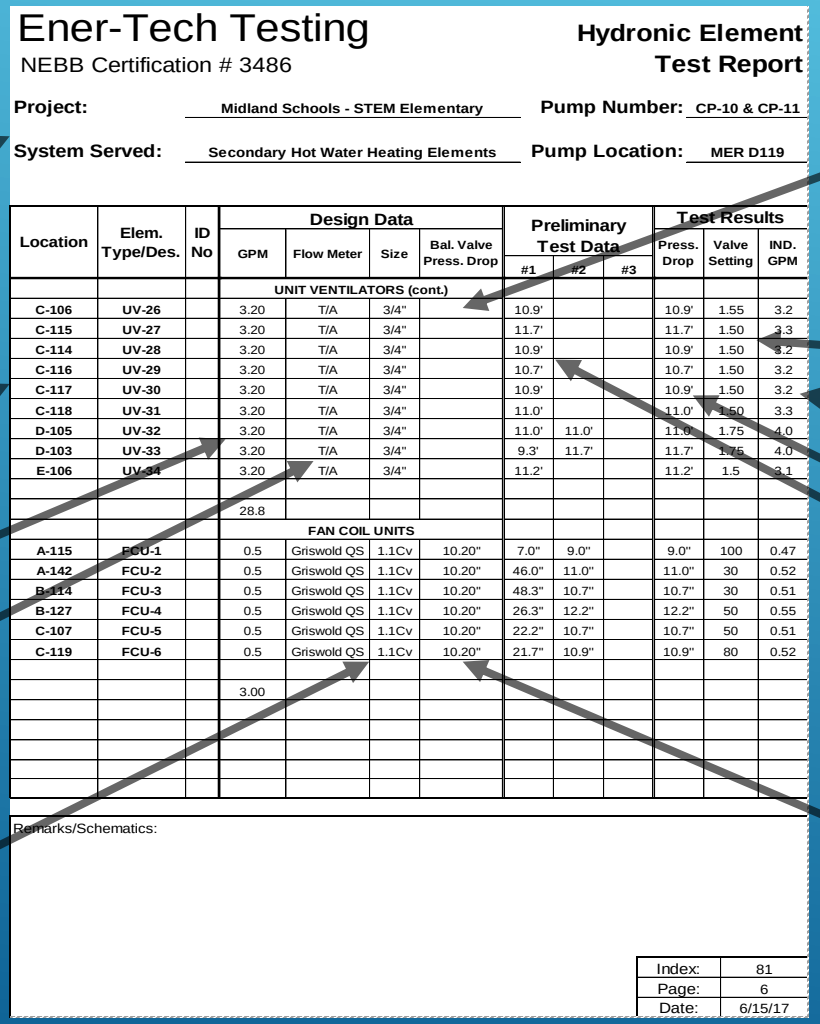
Differential pressure required at a given GPM

Replaces form F-4040

4/16
F-4040H
2803 Barranca Parkway, Irvine, CA 92606
(949) 559-6000 Fax (949) 559-6088
www.GriswoldControls.com

GRISWOLD CONTROLS

HYDRONIC ELEMENT TEST REPORT



Ener-Tech Testing
NEBB Certification # 3486

Hydronic Element Test Report

Project: Midland Schools - STEM Elementary
Pump Number: CP-10 & CP-11
System Served: Secondary Hot Water Heating Elements
Pump Location: MER D119

Location	Elem. Type/Des.	ID No	Design Data GPM	Flow Meter	Size	Bal. Valve Press. Drop	Preliminary Test Data #1	#2	#3	Test Results Press. Drop	Valve Setting	IND. GPM
			UNIT VENTILATORS (cont.)									
C-106	UV-26		3.20	T/A	3/4"		10.9'			10.9'	1.55	3.2
C-115	UV-27		3.20	T/A	3/4"		11.7'			11.7'	1.50	3.3
C-114	UV-28		3.20	T/A	3/4"		10.9'			10.9'	1.50	3.2
C-116	UV-29		3.20	T/A	3/4"		10.7'			10.7'	1.50	3.2
C-117	UV-30		3.20	T/A	3/4"		10.9'			10.9'	1.50	3.2
C-118	UV-31		3.20	T/A	3/4"		11.0'			11.0'	1.50	3.3
D-105	UV-32		3.20	T/A	3/4"		11.0'	11.0'		11.0'	1.75	4.0
D-103	UV-33		3.20	T/A	3/4"		9.3'	11.7'		11.7'	1.75	4.0
E-106	UV-34		3.20	T/A	3/4"		11.2'			11.2'	1.5	3.1
			28.8									
			FAN COIL UNITS									
A-115	FCU-1		0.5	Griswold QS	1.1Cv	10.20"	7.0"	9.0"		9.0"	100	0.47
A-142	FCU-2		0.5	Griswold QS	1.1Cv	10.20"	46.0"	11.0"		11.0"	30	0.52
B-114	FCU-3		0.5	Griswold QS	1.1Cv	10.20"	48.3"	10.7"		10.7"	30	0.51
B-127	FCU-4		0.5	Griswold QS	1.1Cv	10.20"	26.3"	12.2"		12.2"	50	0.55
C-107	FCU-5		0.5	Griswold QS	1.1Cv	10.20"	22.2"	10.7"		10.7"	50	0.51
C-119	FCU-6		0.5	Griswold QS	1.1Cv	10.20"	21.7"	10.9"		10.9"	80	0.52
			3.00									

Remarks/Schematics:

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Project name, system served, pump number, location

Room number, element designation

Design GPM

Valve manufacturer and size (T/A is a variable opening type)

Griswold is a fixed opening type valve, the orifice size is given on the valve tag

With a variable opening balance valve,

Valve setting

Final GPM

Pressure drop across the valve

Required “signal” / pressure drop across the valve