Methods Of Conducting Leak And Deflection Test Of Panels For Air Handling Unit Cabinet

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ABSTRACT: Over the last few years , the steps have been made in minimizing air infiltration and exfiltration in air conditioning equipments used in residential and commercial buildings .Both type of leakage from surrounding atmosphere reduces the effective cooling capacity and coefficient of performance of the air conditioner by air approximate 25% . This will show great impact on power consumption .The purpose of paper was to present the laboratory measurements of central air handling unit (AHU) casing performance following all terms of air conditioning , heating & refrigeration institute (AHRI) standards 1350(I.P) and 1351 (S I) manual . Performance was calculated and compared to nominated codes and standards and provide suggestion to specify tighter heating, ventilation and air conditioning systems (HVAC).

INDEX TERMS : AHU , HVAC , panels , leakage , deflection , rating , standards , test ,components , rig , results .

1. INTRODUCTION

Rising power consumption costs precisely affect profit /loss schedules of tenants and business owners. The survey for air conditioner operating in cooling mode consumes more energy than all other services in the buildings. According to ministry of electricity and water (M.E.W) in the state of Kuwait enacted the energy conservation code for buildings MEW/R-6-2018"Ref [1]" .It was amended to set up energy conservation standards for all main energy consuming equipments in buildings. There are many ways to minimize cooling expenses in buildings. First to increase the insulation thickness and density in walls and roof or to reduce the air leakage through building construction. Reducing the leakage rate of cooling systems can likewise conserve energy .The main purpose of this paper to develop a new *procedure* for (AHU) test methods shows the procedure for calculating the leakage test and structure properties of wall constructions.

2. CERTIFIED STANDARD OF AIR HANDLING UNIT CASING

Air conditioning, heating & refrigeration institute (AHRI) standards 1350(I.P) and 1351 (S I) "Ref [2]", shows mechanical performance rating of central station air handing unit casing

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2.1 LEAKAGE CLASS

Air handling unit (AHU) casing certification in accordance with AHRI-1350 shown in table (1) "Ref [1]". It show the maximum expected air flow leakage (CFM/100FT²) of the (AHU) casing surface area running under the negative and positive pressure as shown in figure (1).

Table (1) *Class - Casing Air Leakage Rating*

Leakage Class	Maximum Casing Air Leakage Rate, CLr, cfm/100 ft^2 (at P_r = 1 in. H2O)	Passing Result, Maximum Casing Air Leakage Rate, CLr, cfm/100 ft^2 (at P_r = 1 in. H2O)
CL1	1	1.05
CL2	2	2.10
CL3	3	3.15
CL6	6	6.30
CL12	12	12.60
CL24	24	25.20
CL100	100	105
Note: If a sample fails a test at CL100, the model is not eligible for AHRI certification.		

CL = Casing Air Leakage Rate, CFM/100ft²
CL_m= Measured leakage, CFM/100ft ^{2} at P_m
P_m = Absolute value of test differential pressure, in. H_2O
P_r = Reference pressure, 1.0 in, H_2O

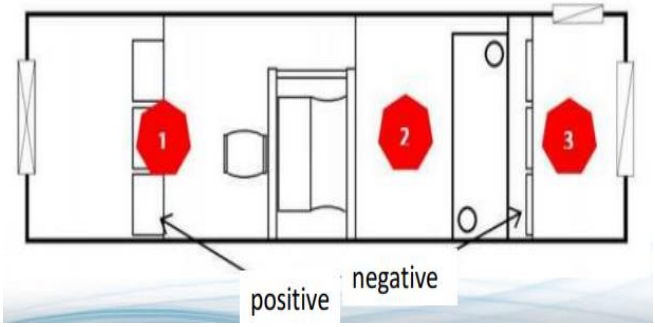

Figure (1) *casing surface area running under the negative and positive pressure*

2.2 CASING DEFLECTION CLASS

The deformation of the AHU casing surface measured at 90° degree to the body of the casing surface, when the equipment is under positive and negative internal pressure. All calculated standard result are tabulated by (AHRI) and published as shown in table (2).

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Table (2) *Class - Casing Deflection Rating*

Deflection Class	Rating Differential Static Pressure, in. H_2O	Maximum Normalized Deflection, in/in of Span	Passing Result, Maximum Normalized Deflection, in/in of Span
CD_1	10	0.0033 (1/300)	≤0.00347 (1/288)
CD_2	8	0.0042 (1/240)	≤ 0.00441 (1/227)
CD_3	6	0.0042 (1/240)	≤ 0.00441 (1/227)
CD_4	4	0.0042 (1/240)	≤ 0.00441 (1/227)
CD_5	1	≥ 0.0042 (1/240)	All test results pass

3. AIR HANDLING UNIT COMPONENTS

Basic types of air handling units (AHU) components are air filter, cooling & heating coil, supply fan and electrical motor as shown in figure (2). All internal components are fixed inside a tightly constructed and high R-value casing .Structural solidity of air handling unit casing is the main issue related to its leakage rate .During the unit operation, a repeated pressurization and depressurization forced on the casing over the time causes fatigue on casing panel seams .A flexible panels will show greater fatigue and failure joint seals.

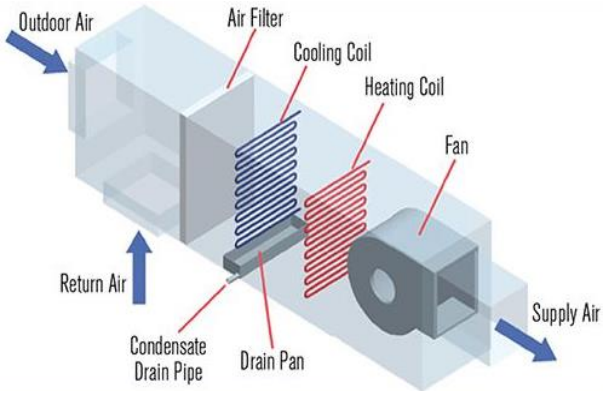

Figure (2) *AHU components*

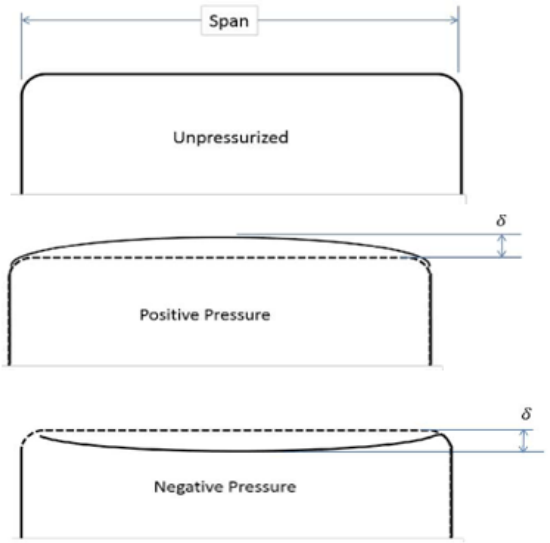

Figure (3) *panel deflection*

The main concern of manufacturers and designers is the AHU panel performance. Therefore, it is essential to give a deflection limit of body panels and leakage rate figure (3). There are many ways and techniques to make the structure of AHU panel more rigid. Using inside ribs supports, increasing the steel sheet gauge and apply rigid insulation.

4. .TEST SET UP & LABORATORY PROCEDURE FOR LEAKAGE TEST

The pressurization and depressurization testing method are according to (SMACNA -DCS -6.2) HVACs duct construction standard- casing " Ref [3]" and (ASTM E1554-07) duct leakage testing "Ref [4]".The leakage test are carried out with all of the unit openings sealed using plywood or sheet metal blanks. Caulking or neoprene gasket is used to effect an air tight seal. The equipment set up for positive pressure test shown in figure (4)

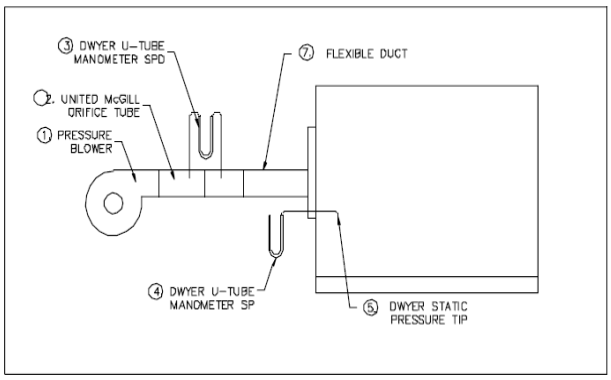

Figure (4) *positive leak test set up*

The equipment set up for negative pressure test shown in figure (5)

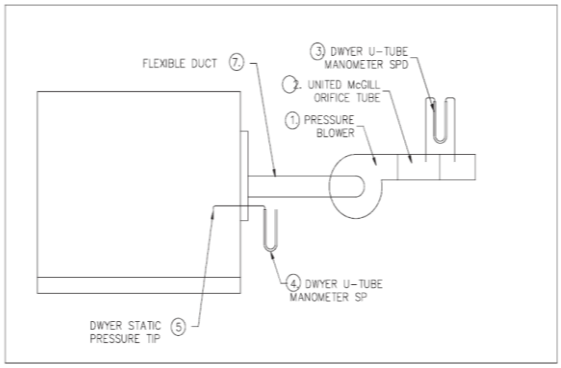

Figure (5) *negative leak test set up*

This was seen the best set up by all members of the testing Laboratory committee and typically , the measurement instruments containing pressure blower , orifice tube – United McGill – 2696-L , Dwyer digital manometer , Dwyer static pressure tip and variable frequency drive .

LEAKAGE	Serial
McGill Air Flow Orifice Tube #6090-5	6090-5

PANEL DEFLECTION	Serial
Mitutoyo Absolute Dial Indicator, Model ID-S1012E	50270

PRESSURE	Serial
Dwyer Digital Manometer, Model 477AV-1	00DQTB

The test pressure is set by energizing the pressure blower. The blower speed is set by a variable frequency drive .The speed is gradually increased until the required static pressure is read on the manometer. The orifice tube consist of a calibrated orifice plate contained inside a six inch diameter round duct ,with static pressure taps on both sides of the orifice .The leakage rate is determined by measuring the static pressure difference across the orifice plate with unit pressurized to required static pressure . This measurement is converted to SCFM using the following formula

6090-S → SCFM (leakage) = 154.261 ∧ .4954
3889-L → SCFM (leakage) = 148,367 ∧. 5014

If the measured leakage rate exceeds the specified maximum, the unit will be examined for leaks and sealed as required. The test will be repeated until the specified leakage rate is attained. The required static pressure at which the leakage test is top be conducted ,and the maximum allowable leakage rate will be determined by the project specification. The results of the leakage test will be reported on a leak test report.

5. FAN CURVE SELECTION

Fan Duty: SUPPLY
Wheel Type: OLHE-ALU
Fan Size: 182
Manufacturer: ENERGY LABS
Fan Model: PLENUM FAN
Maximum RPM: 2959
Fan Class: 2
Qty of Fans: 6

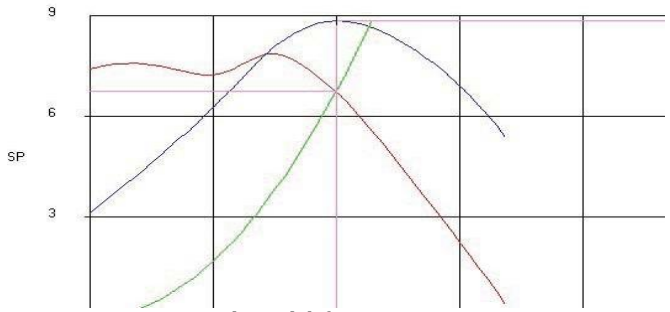

Chart (1) *fan curve*

Table(3) *Operating: Standard*

CFM	6000	--
SP	6.75	6.75
BHP	8.85	8.85
DrHP	N /A	--
RPM	2595	--
ALT	0	0
TEMP	70	70
SE	72	--

table (4)Sound Power

	outlet	Inlet
63	89	87
125	89	82
250	95	92
500	94	98
1K	90	87
2K	86	87
4K	82	85
8K	79	82

Ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311, and comply with the requirements of the AMCA certified ratings program.

- Operating performance and Sound information is for individual fans
- Performance ratings do not include the effect of appurtenances in the airstream
- Performance shown is for installation Type A (free inlet, free outlet)
- The sound power ratings are shown in decibels, referred to 1E-12 watts

6. CABINET LEAKAGE TEST

The principles of test is similar as followed at field for duct leakage as stated in ASTM standard E1554-07. Air leakage is calculated at first at normal AHU operation conditions, followed with positive pressure and negative pressure at all

sides of the unit. During test a super imposed pressure from external fans fixed on units figure (4) to change the pressures in unit. A measured air flows and leakage rates are shown in table (5) and chart (1).

6.1. POSITIVE PRESSURE TEST

Unit Supply Airflow (CFM):36,000
Unit TSP (inches WC):6.75
Specified leakage classification: 5
Test pressure (I.W.G):8
Test pressure = 118.5% of total static pressure
Orifice Tube: Limited McGill 3889 – L
Measured Orifice PD (I.W.G): 0.75
Cabinet Dimensions
H (inches) = 100
W (inches) = 186
L (inches) = 174
Area (sg .ft.) = 949 .5

Table (6) *measured air flows and leakage rates for negative pressure*

	Specified leakage class	Measured performance

Table (7) measured of panel deflection

LOCATION	PANEL LENGTH		ALLOWABLE DEFLECTION			MEASURED DEFLECTION		CONDITION	PRESSURE
A	100.00	In	+ -	0.5000	In	0.1790	In	Pass	Positive
B	100.00	In	+ -	0.5000	In	0.2480	In	Pass	Positive
C	100.00	in	+ -	0.5000	In	0.3740	In	Pass	Positive

Leakage class	5	3.7
% of supply CFM	0.51%	0.37%
Leakage CFM	183.4	134.0
Orifice PD	1.30	0.70
result		pass

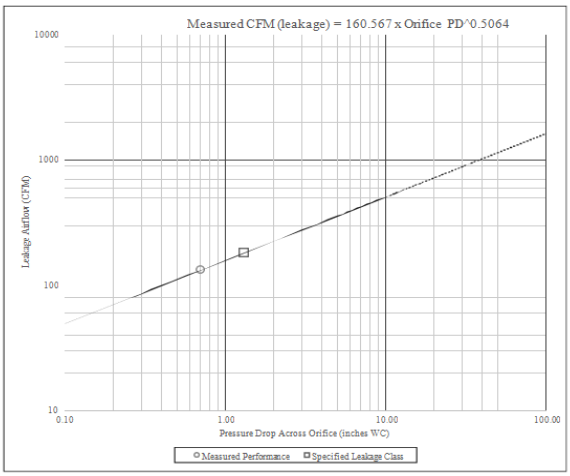

Chart (3) measured air flows and leakage rates – negative pressure

7. PANEL DEFLECTION TEST RESULT

Test made on all A.H.U casing wall. The unit assembled as shown in figure (6).A uniform load applied to all panels, the upper, lower and all side wall of A.H.U casing. Data recorded and results of measurements put in form of table (7) as shown.

Panel Deflection Condition

Test pressure: - 8.00 in H_2O

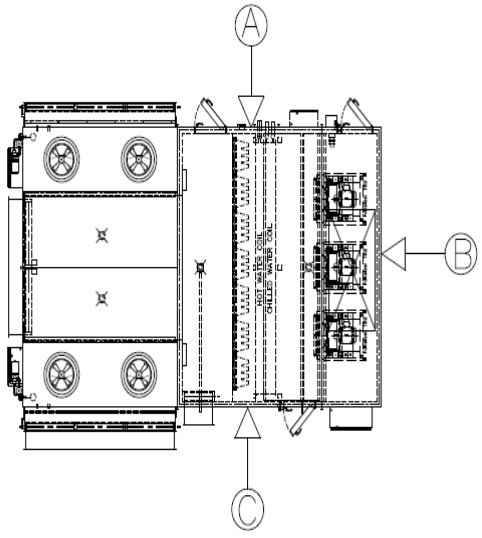

Figure (6) Deflection Location Points

Panel Deflection Tolerance D=L/200

CONCLUSION

The study outlines the procedure and steps of Leak and Deflection Test of Panels for Air Handling Unit casing .The work showed the best set up which can be prepared to show all interested parties an easily And clear program which can be carried out in a uniform manner. In carrying the calculation on data collected and compared to air conditioning , heating & refrigeration institute (AHRI) standards 1350(I.P) and 1351 (S I) “Ref [2]”. All data showed pass result.

. References

[1] State of Kuwait – MEW- enacted the energy conservation code for buildings MEW/R-6-2018.
[2] heating & refrigeration institute (AHRI) standards
[3] SMACNA –DCS-6.2 HVACs duct construction standard- casing.
[4] (ASTM E1554-07) duct leakage testing.