Mandatory Ventilation Air for HVAC Designers

The Florida Mechanical code requires the introduction of ventilation air (air from outdoors) for all buildings to maintain an acceptable indoor environment for the occupants within the enclosed space. Ventilation air that is mechanically induced must be non-contaminated "fresh outdoor air" that is conditioned by the HVAC system prior to delivery into the occupied conditioned space. Ventilation air intake openings to the building exterior should be located a minimum of 10 feet from any noxious contaminant (plumbing vents, chimneys, streets, alleys, pool decks, and parking lots to name a few). Section 403 of the Florida mechanical code prescribes the cfm rate of ventilation air required; the rate is based on the building's space by space classification(s), conditioned area, anticipated occupancy amounts, and occupancy duration. The ventilation air is first conditioned by the HVAC equipment prior to delivery into the breathing zone of each occupied space.

Almost year round the outdoor air in Florida is hot and moist - so a large amount of ventilation air is not desired – the mechanical code requires 15 cfm minimum per person rate to no more than 20 cfm per person is an acceptable range. Occupants who are sensitive to outdoor air contaminants may suffer if the ventilation air rates are too high, and occupants who are sensitive to indoor air contaminants may suffer if the ventilation air rate is too low. The HVAC system must be sized correctly to neutralize the extra heat (sensible heat) and moisture (latent heat) demands associated with the introduction of Florida outdoor air, introducing the correct amount of ventilation air is critical.

Residential ventilation air is required at a minimum rate of 15 cfm of "fresh outdoor air" per person; residential occupant count is set at one person per bedroom plus one extra person. A modern home correctly constructed (2001 or newer) will require mechanically induced ventilation air because the homes building envelope will not naturally "leak" (aka: infiltrate) the code required ventilation air cfm rate amounts especially during part load conditions. Homes constructed after 7/31/2017 requires building envelope construction tightness testing verified by performing a blower door test. Data from many years of blower door testing results show that code compliant homes require mechanically induced ventilation air to maintain a healthy indoor environment. Proposed building infiltration air (infiltration air is natural air leakage that occurs at the building envelope during the peak design hour with a 7.5 MPH wind) cfm calculations are performed prior to construction and "model" a "semi tight" building envelope construction practice for modern homes. Since the calculated infiltration air cfm rate is lower than the code required ventilation air rate, infiltration air will not satisfy the ventilation requirements. Also modern HVAC design guides do not recommend the use of building infiltration as a means to satisfy the ventilation rate for occupant health. Post construction blower door test results will quantify the building's actual natural infiltration air cfm rate; blower door test results less than 3.0 ACH/50 require mechanically induced ventilation air per mandatory code section M401.2, R402.4.1.2. To satisfy the minimum mechanical ventilation air requirement, an intake air opening to an approved location exterior of building, ventilation air duct, air volume control damper, and motorized closure device is added to the hvac system for "run time" ventilation air. This ventilation air duct will induce the ventilation air directly to the hvac equipment return air plenum where the ventilation air will be conditioned prior to delivery to the conditioned spaces. This code minimum ventilation air duct is controlled by the hvac equipment indoor fan interlock to operate only during modes: "fan on", "heating", or "cooling", the ventilation air duct remains sealed air tight while the hvac system indoor fan motor is not in operation. Optional year round ventilating dehumidifiers should be used for year round controlled ventilation and dehumidification that is de-coupled from the hvac system indoor fan interlock and ducting when required. Although the building codes also allow open windows or the operation of bath fans to meet the definition of ventilation air, ACCA Manual J 8th edition shows that these methods are not reliable (who opens windows during the hot summer days!) or recommended. Only mechanically induced ventilation air is acceptable for the southeastern USA.

Below shows a chart with modern “semi tight” construction practices for various homes and a typical hvac equipment schedule showing both the mechanical ventilation rate and the calculated infiltration air rate for a typical home.

1960 - 2000 average leak used

SUMMER INFILTRATION CFM / AVERAGE ENVELOPE CONSTRUCTION PRACTICE			
CONDITIONED SQUARE FEET	1 STORY 3 - 4 EXP.	2 STORY 3 - 4 EXP.	CONDO 1-2 EXP.
UP TO 900	38	49	43
901 - 1500	46	60	54
1501-2000	53	69	61
2001 - 3000	64	84	76
MORE THAN 3000	72	91	82

2001 - semi tight used

SUMMER INFILTRATION CFM / SEMI-TIGHT ENVELOPE CONSTRUCTION PRACTICE			
CONDITIONED SQUARE FEET	1 STORY 3 - 4 EXP.	2 STORY 3 - 4 EXP.	CONDO 1-2 EXP.
UP TO 900	26	34	30
901 - 1500	32	42	36
1501-2000	37	48	43
2001 - 3000	44	60	52
MORE THAN 3000	48	62	58

HEAT PUMP SCHEDULE	
AIR HANDLER MARK:	AHU-1
UNIT MANUFACTURER:	AMERICAN STND
UNIT MODEL NUMBER:	TAM7A0C36H
UNIT DIMEN H/W/D:	56.9x23.5x21.8
UNIT WEIGHT:	146
SUPPLY PLENUM SIZE :	20.5x14.35
RETURN PLENUM SIZE :	20.5x17.15
MANUAL D DUCT CFM:	1200 / .510
SUPPLY FAN CFM / SP :	1230 / .1 to .9
SUPPLY FAN H/P :	1/2
VENTILATION AIR CFM:	60
AHU OFF / INFILTRATION:	48
UNIT PHASE / HERTZ:	1 / 60
UNIT VOLTAGE:	208 / 240
HEATER KW:	3.6 / 4.8
AHU + HEAT MOP:	25 / 30

Based on the chart shown above left for modern home construction, most every home will have a natural infiltration air leakage rate too low to meet the ventilation rate required by ACCA and the mechanical code. Shown right, the hvac equipment schedule for this 3 bedroom home containing 4 occupants shows the natural infiltration air leakage rate for this “semi tight” building envelope to be only 48 cfm (good for only 3 occupants) when the hvac system indoor air fan is off. The equipment schedule also shows a ventilation air duct that indroduces 60 cfm during indoor air fan operation, this ventilation air cfm rate is correct for the 4 occupants in this home. Another benefit of adding a ventilation air duct to a homes return air plenum is that during indoor air fan operation the building’s interior spaces will be slightly pressurized to reduce the infiltration rate, interior building relief air will occur at the intensional building exit points like range hoods, clothes dryers, exhaust fans, and the building envelope components. Ever changing stack and wind forces determine the natural infiltration rate and the mixture percentages of controlled ventilation and uncontrolled infiltration air amounts and the use of some interior appliances can add to the infiltration rates intermittently.

Also note that the modeled infiltration rate calculation is performed during the day time when both external stack and wind forces produce a higher building reakage rate when compared to a windless night. Best practice is to provide enough ventilaton air when the building envelope has no infiltration (outdoor air temperature is about equal to the indoors and there is no wind). HVAC designers should specify this full “worst case” ventilation rate when sizing the ventilation air duct with 20% allowance for future adjustments. Upon building completion the indoor air monitoring results will determine if the ventilation air rate requires adjustment.

The Manual J calculations may show a combination of infiltration and ventilation rates, just an infiltration rate, or just a ventilation rate - so long as the rates totaled are equal to the ventilation rate required for the occupants. Since <u>both infiltration and ventilation formulas are identical</u>, best practice is to list zero infiltration with the full ventilation rate being the only entry required in the calculations to represent the worst case conditions for ventilation air induction.

Infiltration: Winter CFM: 60, Summer CFM: 60	1,780	2,092	1,121	3,213
Ventilation: Winter CFM: 0, Summer CFM: 0	0	0	0	0
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Using a single ventilation entry in the manual J calculations reduces confusion and ensures the HVAC installer air balances the ventilation air duct for the full rate. During hot windy days the “uncontrolled” infiltration rate increases

while the “controlled” ventilation rate decreases - and on a cool windless night the infiltration rate is near zero and the ventilation air rate will equal the required rate for occupant health.

The Florida mechanical code section 402 “natural ventilation” shows two alternate methods to meet the ventilation air requirements: 1) operable building openings like windows and doors and 2) building envelope natural infiltration air. The first method allows the occupants to operate windows or doors to meet the ventilation air rate requirements, the minimum amount of readily accessible operable openings to the outdoors must be at least 4% of the floor area being ventilated. This natural ventilation air method of opening windows is not likely to be maintained by the occupants in our region. The second natural ventilation method that meets the code section relies on natural infiltraion air to occur at the building envelope components, this too is not a reliable method of providing ventilation air because the infiltration air rate is highly dependent on environmental conditions like time of year temperature differences across the building envelope, wind, and envelope construction tightness.

Commercial ventilation air is required at a rate shown in table 403.3 of the Florida mechanical code on a conditioned space by space basis. Commercial projects require mechanically induced ventilation air for every space that contains occupants. Occupant amounts, activity levels, duration, and conditioned space classification are all important factors when performing commercial building demand and ventilation air calculations. The ventilation air rate required by the mechanical code will vary depending on building classification and building use (office, church, retail, specialty), each conditioned space classification (conference, waiting, corridor, etc.), and the anticipated hourly occupancy per space. Ventilation should be designed to maintain a neutral or positive interior building; the amount of exhaust air from the building interior must be approximately equal to the amount of ventilation air being introduced into the building interior. The indoor air handler fan must operate continuously during occupied hours (mechanical Code 401.3) when used to introduce the ventilation air, and the ventilation air ducts should be closed by a motorized damper when no occupants are present. Occupants with occupancy durations of less than one hour should be adjusted to 1/2 of the listed ventilation air cfm rate (waiting rooms, conference rooms, exam rooms, etc.) example: a conference room with infrequent meetings – the occupant amount used in the ventilation calculations for the conference room should be based on occupant duration of less than one hour. This adjustment will account for the fact that the occupants can’t simultaneously be in both the conference room and in their offices during the conference meeting.

Shown below is a partial sample of the Florida ventilation air calculation showing the ventilation air requirements for occupants based on space type, space size, expected occupancy count, and occupancy duration.

+	BUILDING VENTILATION CALCULATION							
SQ FT	CLASSIFY	OCCUPANTS	OCCUPANT VA	AREA VA	MAX. VENT AIR	DURATION *	TOTAL AIR	CFM - PERSON
267	Office / Break	2	5	0.06	26.02	1	26.02	13.01
141	Reception / Wait	4	5	0.06	28.46	1	28.46	7.12
BUILDING VENT TOTALS		6				VARIES	54 minimum	70 provided
THIS BUILDING COMPLIES WITH THE 6th EDITION (12/31/2017) FLORIDA MECHANICAL CODE SECTION 403 AND TABLE 403.3.1.1 THE OCCUPANTS SHOWN ARE ACTUAL EXPECTED OCCUPANTS AND MAY DIFFER FROM THE OCCUPANCY SHOWN FOR EGRESS / FIRE CODE VENTILATION AIR RATES ARE ADJUSTED FOR VARIABLE OCCUPANCY BASED ON THE ACTUAL TIME THE OCCUPANT OCCUPIES THE SPACE								