Forum on Moisture Problems in HUD Code homes in hot, humid climates

Case Study

'nother wet wall west of the Gulf

FLORIDA SOLAR ENERGY CENTER
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On Saturday, October 2, I visited the residence with the manufacturer's representative. The purpose of the visit was to try to determine the possible cause(s) of the reported moisture problem noted on the interior surfaces of the exterior walls – especially the utility and hall bathroom areas.

• HOUSE DESCRIPTION....

The house is a doublewide 3-bedroom 2-bath dwelling. The crawlspace skirting is fairly continuous, and a ground cover has not been laid down underneath the home. The major axis of the roof lays in an east-west direction that places the smallest exposed wall area to the greatest sunloading. Heating and cooling is accomplished with a centralized forced air system. A single air handler unit is located in the utility room. The duct system is located under the floor space. The air conditioning compressor is located on the south side of the building near the utility room. A manually controlled exhaust fan in the utility room ceiling provides ventilation.

• OBSERVATIONS....

The interior surface of the exterior wall was soft to the touch in the bathroom area and utility room areas.

The dryer operates a good portion of the day, varying between 2 to 4 hours a day. The utility room door is normally closed, which causes the utility room to act as a return plenum. The ventilation fan operates a majority of the time (it was operating when we arrived). The family dog is allowed in this area and the fan is operated to remove odors created.

The interior gypsum surfaces of the exterior wall have been replaced. The replacement surface where the same – vinyl coated gypsum sheetrock. Additionally, the exterior wall surface (a panelized wood product) has had numerous vents added approximately 12 inches above the interior floor surface. This is believed to reduce moisture within the wall cavity.

A dehumidifier has been provided to the homeowner. According to the homeowner, the operation of the unit does seem to help, but increases the electric bill. The higher electric bill was not acceptable, so the unit has been turned off.

The kitchen and master bathroom supply vents were closed.

The homeowner mentioned that the air conditioning contractor had been there and performed a HUD code duct test (HUD 3280.715 (a)(4)) and indicated that there were no significant problems. The testing was performed with a Retrotec blower door assembly (based on the description supplied by the homeowner).

● **TESTING....**

The house is a system of components, parts and pieces that are put together to form a system designed to provide shelter and comfort for the occupants. When this system does not function properly, testing is required to determine the source or causes of the problem.

A blower door test was done to determine the airtightness of the building envelope. A series of building pressures and associated airflows was recorded. This provides the necessary inputs to determine the CFM50 of the house.

Blower Door Test Results

CFM50 = 1507

[C=162.8, n=0.529, r=0.996]

A duct system airtightness test was also completed. A duct tester was attached to the air handler unit. The supply registers were temporarily sealed off and the system was then depressurized to 25 pascals. The total and outside leakage flow components were measured. An airtight duct system would have zero leakage or both the $CFM25_{total}$ and $CFM25_{out}$ would be 0.

Duct Test Results

$CFM25_{total}$ = 204
$CFM25_{out}$ = 166

In addition to the duct test with a duct tester assembly, a pressure pan test was also completed. This test will indicate relative leakiness of the duct system at each register and grill. The blower door assembly depressurizes the house to 50 pascals and each register / grill is completely covered with the pressure pan. In general, the lower the number (approaching 0.0), the tighter the duct at that location and the leakier the duct, the larger the number (approaching 50.0).

Pressure Pan Test Results

Entry	0.7	LR1	1.0
LR2	0.6	MBed1	0.7
Mbed2	1.1	Mbath	1.2
Dining	1.1	Kitchen1	1.3
Kitchen2	1.1	South Bed	2.2
South Bed 2	2.9	North Bed	0.5
Hall Bath	0.5		

Pressure differential measurements were completed to determine a magnitude and direction of flow across the envelope when the air handler fan operates. Interior door closure effect was also measured when the air handler fan operated.

Condition	Pressure differential (house with reference to outside)
All fans off (wind effect)	-0.5 pa
Air handler on & utility room door open	-0.8 pa
Air handler on & utility room door closed	-0.7 pa
Air handler on and master bedroom door closed	-0.7 pa
Air handler on and all interior doors closed	-2.5 pa

The pressure difference was also measured across each closed door when the air handler fan was operating.

Measurement of pressure across closed doors	Pressure differential (room wrt living room)
Master Suite	2.8 pa
North bedroom	3.0 pa
Utility room	-9.0 pa
Hall bathroom	3.0 pa
South bedroom	6.6 pa

- **CONCLUSIONS....**

The building experiences extended periods of depressurization. This is created by a number of factors.

- The supply side duct leakage is somewhat significant. The operation of the air handler fan causes the house to operate in a slight negative pressure. This is because the supply leaks dump the air into the belly pan area that is open to the crawlspace.
- If and when the air handler fan is off, and the dryer is operating, air is brought into the conditioned space via leaks in the ductwork. The pathway is from the crawlspace through the various holes and penetrations in the rodent barrier, through the duct leaks and then into the house. This increases the moisture content within the house, creating a higher relative humidity.
- The extended operation of the ventilation fan in the utility room creates a slight negative pressure in that room with respect to the exterior. This pressure difference will draw in outside and crawlspace air (also house air as well) through the various penetrations, holes, and cracks that exist between the room and it's surrounding environment.
- The addition of ventilation holes in the exterior siding may cause problems especially if a negative pressure exists within the home or a portion of the home.
- The operation of the dehumidifier system will assist in the control of the moisture content within the house. However, the pathways and drivers of moisture infiltration should be controlled so that the dehumidifier and air conditioning system (which also dehumidifies) are not overwhelmed with moisture.

- **RECOMMENDATIONS....**

A number of factors must be considered in the proper retrofit of this home to ensure that failure does not happen again. The following should be done:

Air conditioning and heating system:

- All supply duct system leaks should be air sealed with a mastic (such as RCD#6 or equivalent). The seal must be applied to the air barrier ductwork. The areas to be sealed include all of the supply duct risers connections to the main trunk line and the connection of the air handler unit to the main trunk line (this was not checked at the time of my inspection – but should be carefully considered in the retrofit).
- The air balance of the duct system should be checked. This should be done with all of the interior doors closed. The South bedroom is in need of a return air pathway. This may be accomplished by installing a pass-thru grill between the bedroom and the main body of the house. The pressure differentials across the various closed bedroom doors should be checked and be less than 3 pascals. The pressure differential from the living area to the outside should be 0 when the interior doors are open and no more than 3 pascals when all interior doors are closed (ideally this should also be 0 for best performance.)
- All supply registers should be open when the central heating and air conditioning system operates.

Wall assembly:

- All damage wall panels should be removed and replaced. The replacement panels should be finished with a vapor permeable material to allow moisture movement to the inside. The ideal location for a vapor retarder is on the warm side of the wall. In the hot, humid climate, the warm side is the exterior (ASHRAE Fundamentals 1989, Chapter 21). The exterior plywood sheathing will act as a vapor retarder in this case. Every material located to the inside of the plywood should be at least ten times more permeable to allow for drying to the inside. The placement of a vapor barrier behind the gypsum wallboard should be avoided. This may cause condensation to occur within the wall assembly and causing the structure of the building to be damaged.

Crawlspace

- A vapor barrier ground cover would reduce the amount of moisture coming into the crawlspace from the ground. This will tend eliminate some of the moisture in this area, especially with a tighter skirting surrounding the home.