

Buildings Are Getting Greener, But Are They Getting Better?

Do Green Labeled Building Materials or Certification Guaranty Success?

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The energy crisis we are facing, public perception of global warming, media coverage and better awareness by building owners is fueling a “Green Building” explosion. Everywhere one looks today, there is some mention of “going green”. So what exactly is “going green”? The answer to that question all depends on who you ask. I also think asking the question, “are green buildings actually better” would elicit numerous responses, and again it would depend on who you asked.

Currently, there are numerous programs that are called green building programs (e.g. LEED®, Green Globes, Global Green USA, NAHB National Green Building Program, etc.). Each program, although there are many similarities, have many differences. First, there does not appear to be any national consensus on what constitutes a green building or exactly what it takes to build one. Many believe that simply using products and materials labeled as “green” is all that is required. Those companies using green labeled products to achieve, so-called green building status will be likely to fuel the green building failures that are looming on the horizon. It has been our experience at C.L.I. Group that green materials do not compensate for poor quality construction, poor design or poorly understood building operations. These problems all remain, even in green buildings.

Let’s forget the term “Green Building” for a moment and simply look at the state of the construction industry. Wages are going down not up, and fewer qualified technicians are choosing to make careers as carpenters, ironworkers, electrician, HVAC installers or plumbers. I find this apparent each time I am called to investigate a failure in a new building. The materials have changed in many cases, but not the craftsmanship. There is still a large void in the industry which is keeping forensic investigators, indoor air quality technicians and attorneys busy. Again, great materials will not compensate for careless construction practices. So what’s missing? Many building owners believe that hiring qualified contractors, performing building commissioning or hiring a good design team is a guaranty that there will not be any problems yet buildings today are failing the same as always. A few facts become clear to forensic investigators that see these building failures regularly:

1. Good design cannot compensate for poor workmanship.
2. Commissioning cannot correct poor designs.
3. There is no such thing as “cookie cutter” buildings. Each building reacts differently, even if built from similar or identical plans.
4. New materials have not withstood the test of time.
5. Building air infiltration is largely ignored and/or minimized leading to condensation/mold potentials.

In many cases, those installing the new materials have little understanding of the materials or how they relate to the building “holistically”. This appears to be the major area that needs to be addressed in today’s buildings. We still use the segmented approach to constructing buildings with each party on their own mission and not fully understanding how the building operates as a whole. At a minimum, all field supervision should have a good knowledge of the materials and methodologies being used in constructing the building so that deficiencies can be spotted early on in the design/construction process. The problems of building moisture, mold, etc. appear to be getting worse, not better. This is a direct result of technologies and materials which have outpaced the knowledge of designers, builders and maintenance personnel.

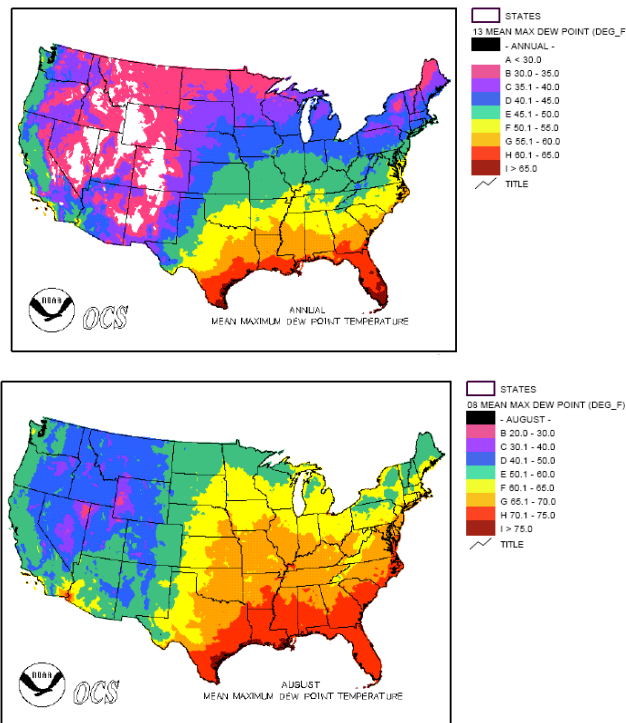
There is currently a “Total Building Commissioning” process being developed that may work to alleviate some of the confusion which is leading to building failures by utilizing a commissioning protocol that looks at the total building as opposed to the traditional HVAC, controls and lighting. The recently released N.I.B.S. Guideline 3 for commissioning the building enclosure systems is an important and often overlooked or poorly understood piece of the puzzle. Many of the building deficiencies discovered during our investigations have led to building degradation, indoor air quality problems and mold are directly

related to the building enclosure and the interaction between the HVAC systems and the building enclosure. Below is the definition of total building commissioning from the N.I.B.S. website.

TOTAL BUILDING COMMISSIONING (TBC):

TBC is an industry-wide program to develop a comprehensive set of building system commissioning guidelines. TBC is the systematic process of ensuring that the performance of the facility and its major systems meet the design intent and the owner/occupant functional and operational needs. The program's goals are: 1) effective documentation of owner performance requirements; 2) effective documentation of design intent; 3) identify & perform tests that show the building and its systems function as required, and 4) to provide a comprehensive and appropriate basis for the training of building operators. NIBS and ASHRAE have developed Guideline 0: The Commissioning Process. ASHRAE is currently developing Guideline I: HVAC Systems and NIBS has recently released Guideline 3: Enclosure Systems based on Guideline 0.

The N.I.B.S. Guideline 3 for enclosures is long overdue. The enclosure is critical to the overall performance of the building and is especially important to properly sizing, operating and understanding the HVAC systems, building pressurization, etc. The number of moisture and mold related issues in buildings today attests to the fact that the enclosure is all too often overlooked and/or over simplified by designers. Below are two maps showing mean max. dew point temperatures for the U.S., the first showing annual mean max. dew point and the second showing mean max. dew point for August. Looking at Ohio for example, if the design team uses the annual figures and underestimates the air infiltration through the building enclosure, the systems may not be able to adequately remove moisture in August when dew point temperatures are considerably higher on average.



Designers that do not consider air infiltration or differing dew point temperatures may be considering later what caused the moisture related problems that the building is experiencing. If the building is also suffering from pressure imbalances, these problems could magnify.

Below are some photos taken on a recent project, which illustrate the potential problems described.



The building shown in the photo on the left was suffering from comfort issues, condensation problems and frozen sprinkler pipes. This building was found to be suffering from many issues related to both design and installation. The building was conditioned using two heat pumps with air handlers installed in drop ceiling area close to where the photo was taken. A visual inspection of the ductwork and air handlers revealed visible leakage in both supply and return ducts and limited (R2) insulation on ducts. This building was acting as a connector between two main buildings. The building pressures were evaluated with reference to both outdoors and the two connecting buildings, and were severely negative with reference to both.



year.

The negative pressures, coupled with sprinkler pipes in the drop ceiling spelled disaster for this project. The photo on the left shows batt insulation exposed to the exterior inside of the soffit area. This allows for a significant amount of wind washing which reduces the R-value and allows for large convective heat losses. In locating this problem, we also noted moisture staining around several supply air diffusers in the building. This was a direct result of cold air in the ducts in the summer, building depressurization acting as the driving force and warm, humid air entering the drop ceiling cavity during hot, humid summer months. Air leakage of this magnitude affects the building all throughout the



Another photo from the same project shows polystyrene insulation which does not cover the sheathing to top of wall. In addition, the exposed sheathing has exposed joints, which allows for additional air leakage and thermal bridging. The problems in this building were exacerbated by steel stud framing and poor batt insulation installation. This building illustrates the fact that although modern materials are used, negligence during installation can erase any added value of using quality materials.

The conditions discovered during our investigation of the problems in this building also show what air infiltration can do to a building. As shown in the mean max. dew point maps above, depressurization, coupled with high dew point temperature in months such as August and the temperature of steel studs and ducts below the dew point equal several opportunities for moisture problems to occur. These issues would have all been discovered during commissioning during either the design phase or construction phase of the project and could have been corrected at little or no cost.

Unfortunately, the problems described above are quite common. The costs associated with problems such as these can get quite high when you consider the costs involved in indoor air quality complaints, building degradation, comfort issues and litigation. Many of these problems in new construction are a direct result of faulty assumptions. The owner assumes that using high quality materials will result in a quality building, the designers assume that the building enclosure is tight, the general contractor assumes that their subcontractors are going to perform quality work and designers assume that this is a cold climate (per code) and therefore condensation problems will not occur here. Let's consider some recently published numbers on building moisture issues.

“Moisture Damage Contributes to 90% of All Building and Building Material Failures” (ASHRAE)

“Moisture Leading Cause of Building Problems Costing More Than \$9 Billion Annually in U.S.” (ASTM)

“Moisture Will Replace Asbestos as the Most Frequently Mentioned Topic in Building Litigation” (C. Gaal, NJ Investigation Commission Counsel)

- Source: Oak Ridge National Laboratory (U.S.DOE)

Surveys of extensive water damage in North Carolina and the lower mainland of British Columbia, Canada¹, have shown that 45 percent of the water intrusion into the building envelope occurred through or around windows. Common elements were poorly performing windows and a lack of flashing to drain intruding water to the exterior.

In Vancouver, BC, it was reported that 50 percent of buildings where the cladding was removed had the building paper lapped backwards².

- Which Way Did It Go?, John Edgar, Sto Corp, Atlanta GA, Symposium on Building Envelope Technology, November 2007

The above numbers make the case for using a “holistic” approach to building commissioning an even stronger case. Moisture issues require an additional level of protection and experience on the team. The commissioning of the envelope to protect against moisture and mold issues should begin early in the design phase of a project.

Back to the word “Green Building”. Making the assumption that using paperless drywall will take care of the mold issue is wishful thinking. Thinking that sloping the grading will eliminate all opportunities for moisture intrusion, again, wishful thinking. While paperless drywall and a correctly sloped grade may be steps that can lessen the risks, the building must be evaluated from the design phase and all potential sources of moisture intrusion must be considered.

A recently published story in the Venice Gondolier tells of Sarasota County Florida’s “green” sustainability program taking one on the chin recently. The county’s administrative Twin Lakes Green Building Complex has mold—enough to require evacuation of the building, according to County Administrator Jim Ley. The U.S. Green Building Council awarded the complex (which consists of the newer solar-powered, 8,300-square-foot Building B and the renovated, 19,250-square-foot Building A) its prestigious gold-level Leadership in Energy and Environmental Design certification in 2005. The designation recognizes buildings and grounds that are “environmentally responsible, profitable and healthy places to live and work.”

Spending the money to gain a LEED™ certification while not paying attention to detail will result in failures the same as it does on so many buildings in general. The process of commissioning the building which is a prerequisite for LEED™ and also performing the enhanced commissioning for additional credits will do little to protect the building if the ONLY motivation for applying for the credits are the points. There must be further consideration than achieving points if LEED™ is going to work. These considerations have to begin early in the planning phase of the project and must follow through during the lifetime of the building, paying special attention to details. Having investigated hundreds of buildings that have experienced failures in one form or another has taught us some valuable lessons about the value of commissioning, value engineering, green building methodologies and materials and design and construction and how they should and often do not work together to achieve success.

I have sat down over the past year with some of the engineering firms that C.L.I. Group has worked with and discussed the need for additional commissioning as it relates to the building enclosure. The reception for such an idea has typically met resistance. The reason, additional costs added to the project. It is my feeling that this skepticism is both unwarranted and foolish. With building moisture being at the top of the list for both building failures and litigation, it would seem that enhancing the commissioning in this area makes sound financial sense. The costs involved in correcting design or construction related moisture issues in a building after the building is occupied far outweigh any additional cost incurred in commissioning the enclosure in some fashion. The owner’s interests can only be achieved if the intent of the design is achieved over the long term. A dry, habitable, energy efficient and environmentally friendly environment is the goal that is all too often not being met over the life of a building.

¹ Survey of Building Envelope Failures in the Coastal Climate of British Columbia, Study by Morrison Hershfield for Canada Mortgage and Housing Corp., 1998

² Edgar, J., “Performance of Source Drainage External Insulation and Finish System,” Journal of Thermal Envelope & Building Science, Volume 23, July 1999

Anyone involved in forensic investigations of building failures understands the need for a better understanding and commissioning of the building enclosure. I have spent time in training classes for air balancing and diagnostics and again have witnessed failed buildings, poor dehumidification and poor indoor air quality resulting from test & balance contractors that completely overlook the role of the building enclosure on the HVAC systems. If 30% of the conditioned air is being lost to envelope leakage and 30% of return air is being pulled in through the building envelope, how can a system possibly function as intended? Answer, It Can't!! Yet, the balancing report may reflect that the systems are balanced. This is a case where no one on the project has any idea of the role that pressures play in performance.

This past year, we were called on to investigate moisture intrusion issues in a large local church. The maintenance staff informed us that there was some leakage which was staining walls and it was related to the below grade doors to classrooms leaking. Our investigation revealed something quite different.



Figure 1 Damage behind carpeted walls

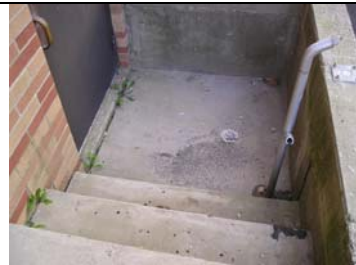


Figure 2 Below grade door to classroom

Our initial evaluation included a non-destructive assessment of the building, exterior wall scan using infrared thermography, plan review, moisture meter readings in suspect areas, particulate counts and building parameter evaluation (CO₂, temperature, %rh, dew points). What we discovered from the initial non-destructive evaluation were exterior walls that were suffering from elevated moisture levels, elevated moisture in various demising wall cavities, significant amounts of visible mold, significant pressure imbalances and poor design of the exterior walls (per plan review). At this stage, a remediation contractor was brought in to arrange containment of the suspected areas of the building and further evaluations were performed including air sampling for bioaerosols. The results of the air samples confirmed our suspicions. At this point the problems were becoming more apparent so we looked at the design and performed some modeling of the exterior walls.



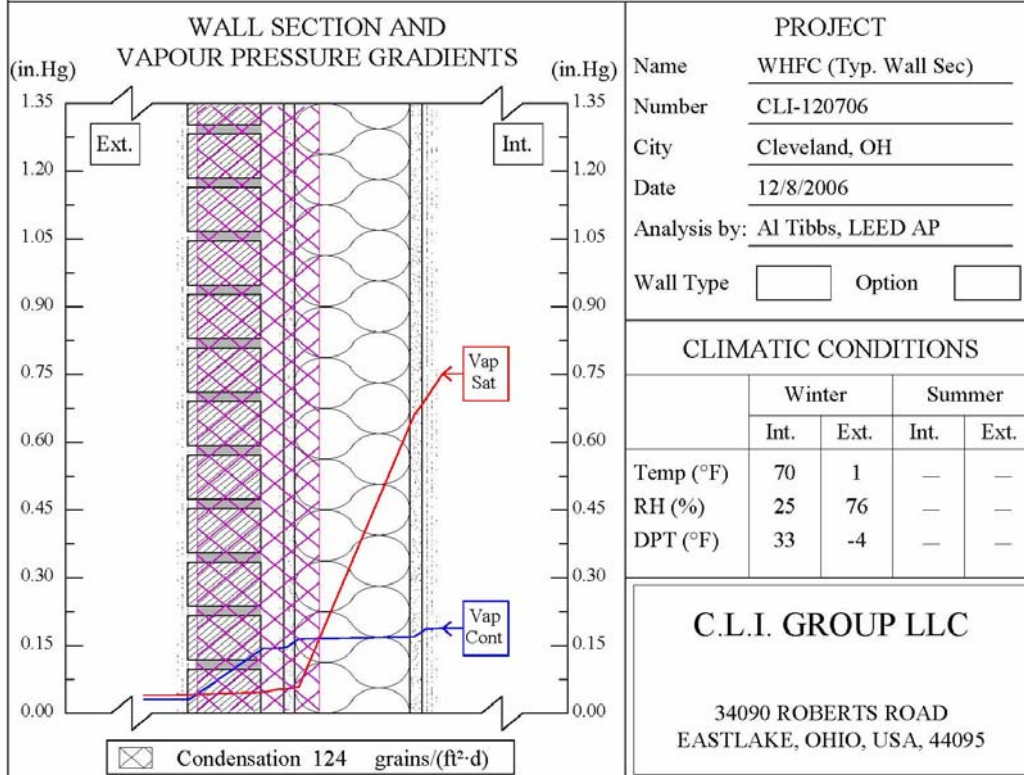
Figure 3 Inside exterior wall cavity



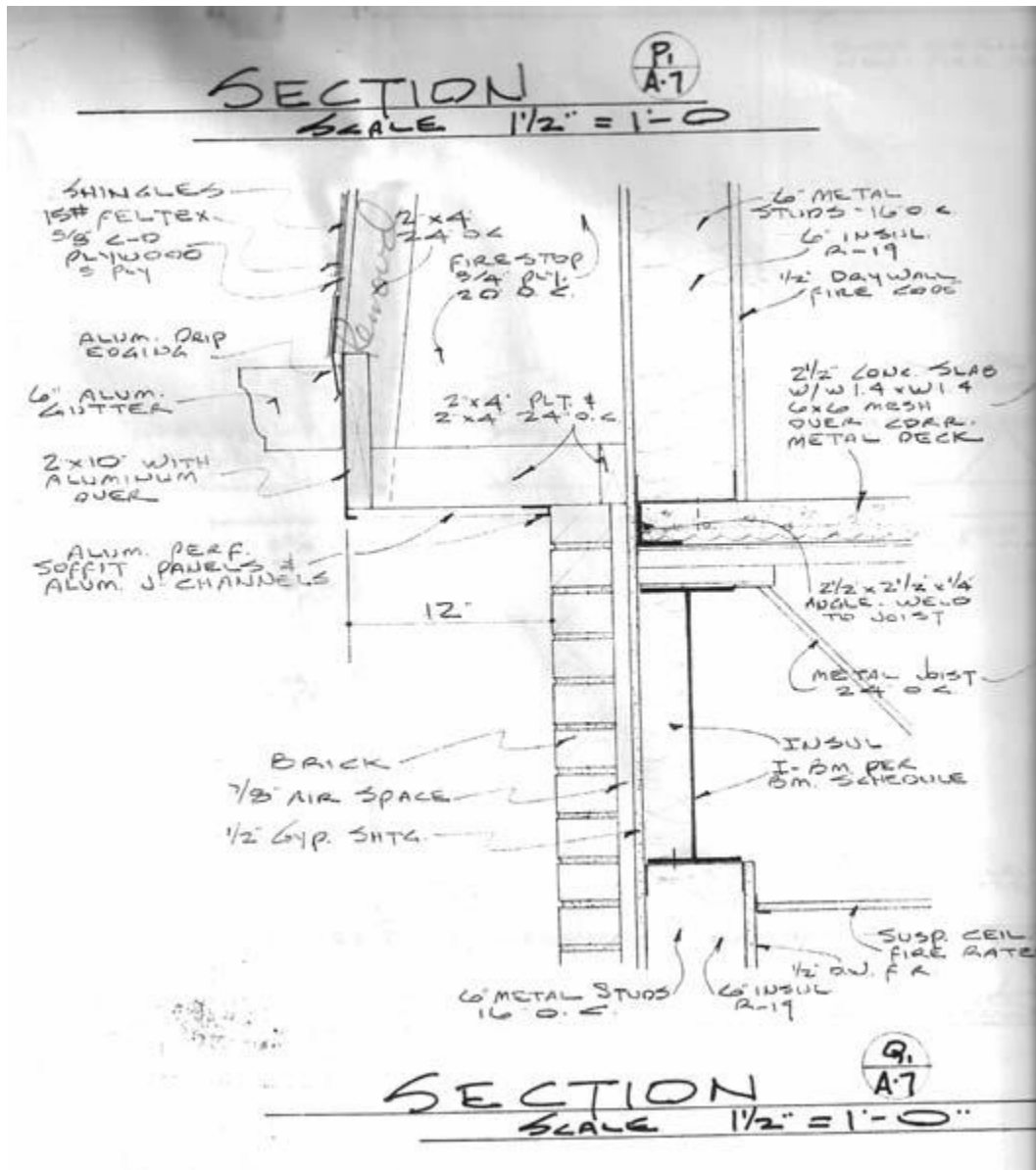
Figure 4 Steel stud, batt insulation, water damage

CONDENSATION ANALYSIS

C.L.I. Group, LLC Heat, Air and Moisture Analysis



	Material	Manufacturer	Model No.	Rvap (1/M)	Temp (°F)	VapSat (in.Hg)	VapCont (in.Hg)
1	air film (ext), 3/4 in.	No Recor...	Generic...	0.001	1.6	0.041	0.030
2	brick, (unvntd), 4 in.	No Recor...	Generic...	1.249	3.8	0.046	0.142
3	cavity, 3/4 in.	No Recor...	Generic...	0.006	6.2	0.052	0.142
4	paper, stand., (8mil)	No Recor...	Generic...	0.023	6.6	0.053	0.144
5	gypsum bd., 1/2 in., (#1)	No Recor...	Generic...	0.198	8.2	0.057	0.162
6	batt ins., 5-1/2 in.	No Recor...	Generic...	0.052	66.2	0.649	0.167
7	gypsum bd., 1/2 in., (#2)	No Recor...	Generic...	0.198	67.8	0.686	0.184
8	air film (int), 3/4 in.	No Recor...	Generic...	0.006	70.0	0.740	0.185
9							
10							
11							
12							
	TOTAL or (Layer 0)			1.733	(1.0)	(0.040)	(0.030)



The condensation analysis indicates that dew point is being reached within the fiberglass batt insulation. This leaves the inside face of exterior sheathing and steel studs as first condensing surfaces. When performing an evaluation of the plans we noticed several areas of concern. Below are some of those concerns:

1. The airspace behind the masonry veneer was $\frac{3}{4}$ ". This is inadequate for several reasons. It allowed the space to be clogged by grout from wall during construction. Poor drainage plane.
2. There is no exterior insulation (continuous insulation).
3. Steel studs, no exterior insulation, poorly installed fiberglass batts and poorly installed air barrier allow for air leakage of humid outdoor air in summer and lowers interior surface dew points in summer.
4. Depressurization due to imbalances in mechanical systems are allowing drop ceiling plenums to pull return air through building enclosure instead of conditioned space.
5. 6 inch steel stud wall does not allow for adequate insulation for this application. Reduced resistance due to air infiltration/wind washing.

6. No mortar blocking installed (e.g. Mortar Net) to keep grout from blocking weeps.

Our findings in this building were both very significant and very surprising to the owner. This was especially surprising (in light of mold/moisture in the news) because the building was only a few years old. These issues could have easily been prevented with no additional costs if the envelope had been commissioned by an independent third party. The fees paid for the commissioning would have been offset by energy, maintenance/repair, and liability savings. When discussing our findings, we were told by building maintenance personnel that this could not be possible as the building had been commissioned and there was a commissioning report. We still have a long way to go in commissioning buildings. There are many that still believe that traditional commissioning of HVAC, controls and lighting are all that is needed. The case we have just discussed proves this thinking to be faulty of course.

As “green building” becomes the industry buzzword, I hope that building owners, designers and contractors do not fall into the same sense of false security that comes along with every unproven new product. The products will not matter much, if we do not take the time to properly plan, construct and test new buildings. There is no product that I know of, either green or not, that takes the place of proper design and commissioning of buildings and their integrated systems. The industry as a whole needs to take the time to properly train the parties involved in the meaning of integrated building design and performance so we can quit evaluating the same mistakes over and over again.

C.L.I. Group, LLC is a forensic building investigation firm located in Cleveland, Ohio. C.L.I. Group, LLC specializes in building failure investigations, energy ratings and audits, HVAC system air balancing & diagnostics, indoor air quality, infrared thermography, construction oversight and LEED™/HERS consulting.