EE6-3 Brick Veneer Steel Stud (BV-SS) Wall Systems and Insulated Composite Backup (ICB) Panels

Keith D. Boyer[1], John Preece[2]

Abstract

Brick veneer over metal stud framing creates several challenges related to control of moisture originated from rainwater and vapor drive. This is especially true with systems that have multiple components and erectors to install the needed air, water, vapor and thermal barriers. There have been many reported water-related problems with multiple-component assemblies.

These barriers are more effectively achieved with one structural composite product and one installation through the use of specially designed insulated composite backup (ICB) panels. In this solution an exterior rain screen leads water down the steel face of the composite panel to drain at the base of the wall. Structural joints and factory seals, as well as closed-cell foam core material are placed on the exterior side of the stud cavity. Exterior insulation and high air and water resistance with minimal water entrapment, eliminating dew point and mold concerns are characteristics of the system. Specially designed clips allow for brick tie connections without compromising the system performance. This system is code-compliant and accepted by consultants in the wall industry.

Introduction

Brick Veneer systems over metal stud framing have become prevalent in the construction of architectural walls in commercial buildings. Depending on how they are erected there can be challenging performance issues related to moisture entrapment within the wall cavity. This paper describes some of these issues and offers a new building science based approach that combined with actual building experience led to development of this new system.

1. Keith D. Boyer, CENTRIA, Pittsburgh, PA

2. John Preece, 90ten Architects, Lawrenceville, GA

Critical Barriers in Building Enclosure

In addition to the obvious structural and fire requirements, all architectural walls must establish four critical “barriers” as described by Gabby and Cammalleri (2006). These barriers and their key attributes are listed in **Table 1**.

Table 1: Critical barriers in building encloure

Barrier Type	**Key Attributes**
Air	Impermeable to air infiltration
	Easily seamed
	Able to resist structural loads from pressure differences
Water	Able to keep rainwater out of wall cavity / building interior
Vapor	Controlling vapor diffusion
	Some have varying permeance as a function of RH for use in moderate climates
Thermal	Able to achieve continuous insulation over the wall to achieve highest efficiency

Generally these barriers must have continuity within any type of system. And, when used on a building with multiple wall types, it is extremely important to make sure that these barriers are compatible and continuous from one system type to another such as brick to metal wall areas or other opaque walls to curtain walls or wall to roof areas. Of particular note are the air barriers which must be connected. A discontinuity in the air barrier can allow moisture laden air to run through the wall carried with air flow in a circuitous path. If contacting surfaces below the dew point, vapor in the air will condense and lead to entrapped moisture which could cause material degradation and structural loss, thermal loss and/ or mold. See **Figure 1.**

The selection of material type and location for vapor barriers/ retarders within the wall system is the complex and is dependent on climate zones and building interior operating conditions. Improper material choices and location within the wall assembly can lead to similar moisture entrapment issues.

Figure 1: Example of a disconnect between wall and roof air barriers

Evolution of Wall Assemblies with Metal Studs

Metal studs have been widely utilized as the support system for exterior walls. To establish the four critical performance barriers, multiple materials installed by multiple trades are often selected. These systems are referred to as Multi Component Wall (MCW) systems. Early designs used glass fiber insulation within the cavity with an interior vapor barrier (if needed) and an exterior sheathing, air barrier, sub-frame (if needed) and cladding. (**Figure 2**)This system has several faults. The most notable performance issue is that the cavity insulation value is reduced by as much as 65% (as shown in **Figure 5** quoted from ASHRAE 90.1-2007) due to metal stud thermal conductivity. Other problems arise when the vapor barrier acts as the air barrier and is placed on the interior side of the stud frame. This selection makes the effectiveness of both barriers suspect since it is nearly impossible to attain continuity.

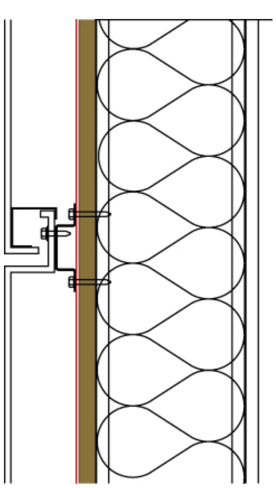

Figure 2: Stud cavity insulated

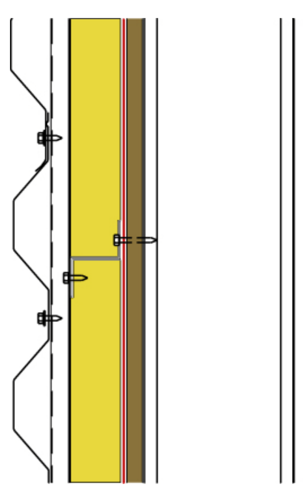

Figure 3: Board stock over sheathing

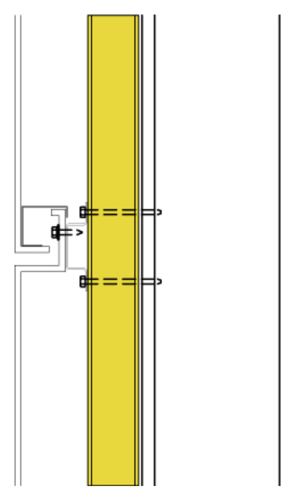

Figure4: ICBP on studs

Nominal Framing Depth	Nominal Insulation R-Value	X	Correction Factor	=	Effective R-Value
4" @ 16" O.C.	R-15	X	0.43	=	R-6.4
4" @ 24" O.C.	R-15	X	0.52	=	R-7.8
6" @ 16" O.C.	R-21	X	0.35	=	R-7.4
6" @ 24" O.C.	R-21	X	0.43	=	R-9.0

Fig. 5 Reductions in nominal R- value for glass fiber in metal stud assemblies (AHRAE, 2007)

These as-built shortcomings are cause for concern with regard to moisture retention and entrapment within the wall cavity. In particular, a wetted brick veneer (and the drain cavity behind the brick) causes extreme vapor pressure on the exterior components when heated from solar gain causing additional moisture entrapment concerns within the wall assembly especially if a required interior vapor barrier or a vapor impermeable wall covering is used. (Lstiburek, 2001)

Progress was made with the '01 Massachusetts Building Code. Different assemblies were prescribed by the code language to improve on some of the stud cavity insulated system shortcomings. The four barriers were moved to the exterior of the stud support frame on top of an exterior sheathing which allowed these components to have a better chance of continuity and efficiency. To minimize the wall system depth, high efficiency foam insulation is most frequently chosen. **(Figure 3)** While fewer in number, there still are some potential shortcomings. The system is still a **MCWS** and multiple trades are required to erect it. Also the foam insulation requires multi-story testing per chapter 26 of the IBC, which many times this is not done, and un-faced foam insulation will have some aging effects that decrease the initial insulation values. If the foam cannot support clips or sub framing on the surface of the insulation then some of the board stock thermal continuity could be compromised by the sub-framing penetrating the insulation board. Additionally, moisture can accumulate between separate component layers and may become entrapped within the wall system.

The energy design codes further support the concept with insulation outboard of the stud support frame with increased insulation requirements for opaque wall areas. Insulation requirements have increased substantially from the '04 ASHRAE 90.1 design standard to the '07 ASHRAE standard. R values shown in the attached charts are for opaque wall areas on steel framed buildings. Projections for the '10 ASHRAE standard are even more dramatic. See **Figure 6.** Hence, **wall systems that are insulated outboard of the stud support frame and that can achieve extreme continuous insulation values are here to stay**.

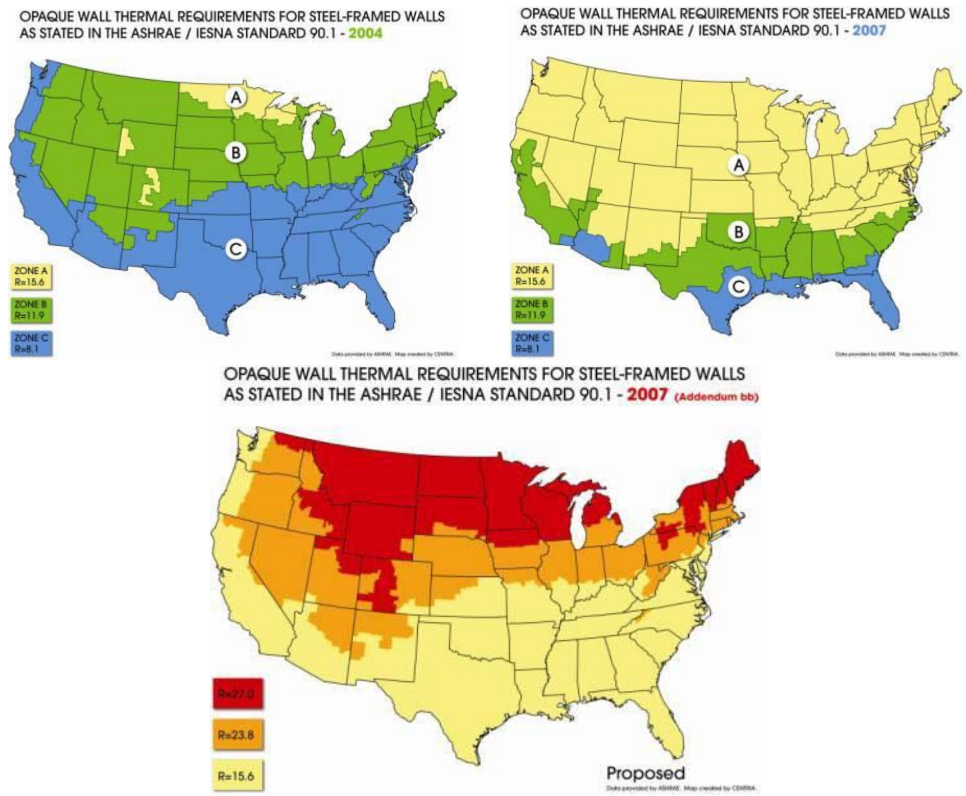

Figure 6: Changes in Energy Standards 2004, 2007 and proposed standard

A relatively new component to use with metal stud frame construction is the **insulated composite backup (ICB) panel.** This solution meets the demands of the wall design in supplying a structural panel system that meets the fire code as well as establishing the four barriers. This system is installed by a single contractor, offers excellent insulation that is outboard of the support frame and does not have the aging issues that un-faced insulation has and is able to achieve an air and vapor seal on the interior side within the roll formed joinery. Additionally it allows for sub-framing attachment (to receive façade materials) that has little impact on the product performance. These systems can also avoid the complexities of vapor barriers and their location within the wall assembly. When properly developed, engineered, detailed and installed, ICB panels can be utilized behind many facades such as brick, metal or tile and **can achieve the four critical barriers with the erection of only one component by one contractor. This backup system can also be utilized as a continuous backup behind differing façade materials on the same elevation. (Figure 4)**

Insulated Composite Panels

Insulated composites have been successfully used for over 3 decades as the finished architectural wall system achieving all four barriers with the single product. These applications have been involved in many building types and both large and small. Offices, educational buildings, health care and sports facilities are a few of the markets in which these products have been extensively used and have been performing well. See **Figure 7.**

Figure 7: Projects with Insulated Composites as an Architectural Wall System

When used as a backup panel insulated composites answer all the barrier needs. In all cases and in all climates the **liner side seal technology** has been a **proven method** of applying these products. This seal method connects factory applied seals in the roll formed panel joinery along the panel length to field applied seals at cut ends or edges. The result is a perimeter seal around each panel. The liner is metal and acts as an excellent air and vapor seal. The sealant is a high grade butyl that also has excellent air seal properties and is vapor impermeable. Having the liner seal on the liner side allows the same system to perform in any climate without moisture entrapment concerns.

The metal faced panels have unique properties. The facers separated by the insulated foam core create a strong composite that has spanning capacity. The interior and exterior metal facers are not connected in the side joint which creates a thermally efficient unit. The foam that is visible within the side joints before erection (and concealed after panel installation) separates the inner and outer metal skins and creates a good thermal break. **The closed cell property of the foam does not allow for any moisture or vapor migration within the product. The roll formed side joints along the length of the panel and the factory installed sealant allow for panel-to-panel seals to be easily achieved.**

An Insulated Composite Backup Panel for Brick Veneer

To help control the harsh moist environment in the cavity behind brick veneer and to minimize the multiple trades involved an **ICB** panel erected over stud frames has been adapted for brick veneer. The clips that attach the panel have been designed also to receive the brick ties. Intermediate clips allow for attachment of the brick system in the mid field of the ICBP. See **Figure 8**.The system with a brick veneer has been tested in the NFPA 285 protocol for intermediate scale multi-story assemblies to validate in-place performance of the product in a major fire. And, special accessories and installation techniques allow the product installation to establish continuity of the air, water, and thermal barriers at corners and transition areas and where the ICBP interfaces with adjacent systems.



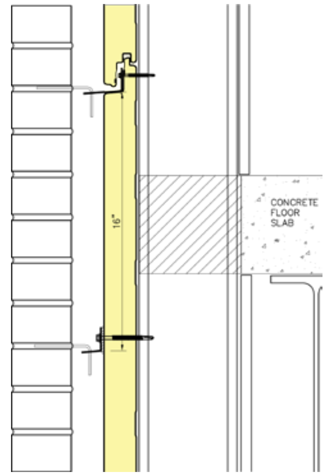

Figure 8. ICBP clips act as brick tie

In the field, standard length product (12' or 20') is used to create the envelope enclosure. The product is easily cut to width or length to fit the building. The product is light (1.6 lbs/sf) and is easily lifted. Field installation training is achieved through hardcopy manuals, cds and/or in person on-site. Future QA procedures will possibly involve erector certification through a program established for the air barrier association of america, abaa.

Installation details have been reviewed by WJE. The brick **ICB** panel concept was also endorsed by Michael Gurevich, a masonry consultant with the NYC Brickwork Design Center. In his 5/08 article in *The Construction Specifier,* Mr. Gurevich reiterates the problems with the stud cavity insulated **MCW system** as well as those that use board stock foam outboard of the stud supports. Mr. Gurevich states

"Specifying a 'single' installation in the form of ICBP could substitute the need for individual exterior gypsum board sheathing, vapor retarder/ air barrier, and the insulation board. This yields not only considerable labor savings, but also reduces the chance for installation error."

An additional benefit may be a positive impact on the project schedule via the elimination of some of the separate wall components and reduced coordination by the GC.

Numerous Brick Veneer projects with metal studs have been completed with this system. To relate the experience from an architect's perspective, Mr. John Preece, an Atlanta based architect, presents his experience in product selection, detailing and application for an actual project in the next section.

Case study: Architect's Perspective

Use of Insulated Composite Back-up Panels (ICBP)

for a Masonry Medical Office

By John Preece – 90ten Architects

Project: Ohio Orthopaedics & Sports Medicine, Location: Findlay, Ohio

Size: Approx 27,000 GSF on two floors plus 6000 SF Basement

Cost: Approx $4,000,000.00 (Approx $145.0/GSF)

Date Built: October 08 – November 09. Architect: Medical Design International

Designer: Jeff Griffin. Project Manager: Richard Lowery, Technology Director: John Preece

Contractor: Claus Construction, Project Manager: Bruce Shook, Superintendent: Jerry Kirian

Now that this project is complete I can happily report that this is a feel of a good story. Of course we start most projects with the expectation that they will ultimately be a success, but along the way each project presents challenges. As architects we have the usual circumstances of budgets, deadlines and client expectations. On that latter point it is a given that the client expects their new building to be designed and constructed to perform well for a long time. While it is de rigueur for architects to deliver on this expectation it is far from easy. This is particularly true considering that the bar for building performance is constantly being raised by influences outside the understanding of the average client. Talk of global climate change, litigation on mold and mildew cases, the relevance of LEED, and the research of building scientists on past technologies to name a few, have created a demand on architects to deliver high performing building envelopes that few practitioners could meet only ten years ago. The good news is that this demand has created somewhat of a renaissance for architects in the technical design arena. While it appears to be too early to say that most architects strive for a thorough analysis and understanding of how their completed projects will perform with respect to building envelopes, it seems clear the movement is well underway, is spreading, and might even join together with function and aesthetics as integral parts of the whole of an architect's concerns. Now, if only the expectation on fees and construction cost were in lock step with this trend, practicing architects would be left with merely the challenge of this daunting triumvirate. Unfortunately, at least for the time being, the constraints of budget seem to be trending inversely due to nearly unprecedented economic forces. If would be really helpful if architects had as a standard of care a selection of products that when used would simply deliver high performance, universal appropriateness, and terrific good looks all for a cost that is equal to or less than the commensurate existing standards. While it will likely never be quite that simple, particularly for whole building assemblies, we all seem to be in search of at least pieces of the puzzle that can take away some of the worry. It is within the context of all of these issues that this story is told.

The piece of the puzzle that this story deals with is sheathing for a brick veneer building. The typical wall section our office had developed at the time of this project was fairly straight forward and well used, consisting of an inch or so of EPS over an air and moisture barrier sheet of spun-bonded poly-olefin, that over 5/8" thick moisture resistant gypsum/fiberglass sheathing panels, all over 6" steel studs with R-19 unfaced batts in the cavity, 5/8" interior gyp board, and in this climate a warm side vapor barrier. If that sounds like a lot of pieces it was and that didn't include the various accessories needed to hold things on the wall and the dozen or so products needed to completely account for the masonry and assorted flashings. While we felt very comfortable with this design we had learned from some recently completed projects that it was still a very tall order to get all of these products on the wall correctly. In fact, thanks to a peer review we had recently experienced on one of our larger projects we were now practicing in an environment of heightened awareness at just how hard it was to achieve a quality constructed enclosure. Even for those with forensic expertise on a project when the GC and subs were willing and eager participants and when the details were developed on a sound platform of building science, it was still difficult. At the time it seemed the battle would just come with the territory. It was also at this time that I attended a BEC seminar at which a new sheathing product was introduced.

The seminar was in Atlanta and occurred in July of 07 and the product was an insulated composite back-up panel, or ICB panel. The presenter for the product had the title of "National Technical Director" for the company he represented and indeed seemed to live up to the billing. I remember thinking as the slide show progressed that the real value of what I was hearing was the lessons on building science and was hopeful that I would remember at least some of them. The physics of the application was easy to grasp and I think I was nearly convinced even after that initial exposure that this offered some really exceptional benefits if everything he said was true. What I took away was a few handouts to file for later and a promise to myself that I would look into the use of this type of product on the occasion of my next new project. When the opportunity arose it was for a project in Ohio for a repeat client; in this case a worthy climate and a trusting patron. I pulled out the information and called the ICB panel manufacturer that I had seen at the BEC seminar to begin my research into this new sheathing.

The process of vetting out a new product, if one is even so inclined, is to try and analyze everything you can think of with the healthy assumption that you will find some reason not to use it and return to what is safe. As with any new product part of the concern is the strength of the company behind it. For this particular product there was a new company involved. In this case however, there was also a parent company that was well known and had been around for over one hundred years. As it turns out the product itself was also not really new and had existed for decades as a single wythe cladding. These were two early litmus tests that I considered as having been passed. Since I was already a fan of the "physics" from the initial seminar the technology analysis was mostly a review and verification of the almost obviously good physical characteristics: thermal resistance – R21 in a three inch panel; air and moisture resistance - no worries through the body of the panel since it was steel skinned and no worries at the seams as it had a documented track record as a cladding assembly surpassing the ABAA requirements as an air barrier. Vapor and fire resistance were essentially non issues. Wow! Here was a product that was going to replace many of the myriad of components that I knew would be a part of the wall otherwise and remove the obligatory battles that would go with it; all with the promise of better performance. This product offered a lower potential for air and moisture infiltration, higher effective thermal performance, a designer dew point location outside the stud cavity and a rock solid vapor barrier to stop the high pressure drives from the masonry through the wall while rendering interior vapor drives essentially moot. Also, right about this time we were given information from the manufacturer that they had shown the product to the same company that had done our peer review. According to the manufacturer the initial response from Wagdy Anis, a source I had come to know well from my involvement with my local BEC chapter, was very favorable and that this product potentially offered "a universal solution". If this was all true then why wouldn't I use it? I could think of two big remaining issues with the obvious downfall here sure to be the cost, and if not that then system completeness. By this time we had invested in the use of the product conceptually and had begun our schematic and design development documents showing the ICB panels. This allowed us to ask for permission from the client to consider use of the panels on the merits of our research to date and also allowed us to begin to investigate both the cost and the product as a comprehensive system.

The cost analysis proved to be the toughest part of the evaluation. For a period of about 6 weeks we struggled to collect data on the cost of the pieces to be replaced as well as the cost of the labor. The cost of the panels themselves was given as about $6.00/sf for 2" thick panels and maybe $.50/sf more to go with the 3" thick panels. The manufacturer made the case that while the material cost would likely be higher for the panels versus the materials for a well designed multi-component wall, overall the installed price would be nearly a wash. They reasoned that since the panels could be installed by a single trade and only required one trip to the wall studs to prepare for the masonry installation as opposed to two or three trips in the multi-component wall this would yield significant labor savings. After our search for real project costs on the component wall pieces turned up empty, we finally resolved to a conservative estimate of $3.50/sf based on data collected from R.S. Means. We wanted to use the 3" panels to respond to the new recommendations from ASHRAE (not code at the time) to upgrade R-values. This gave us a spread of $3.00/sf on the material cost with a quantity estimate of 11,000 sf for an overall material premium of $33,000 for the ICBP's. Given the logic of the case made for labor cost, we conservatively presented a line item extra to the client of $20,000 to $40,000 more for the installed panels. In the end this proved to be an easy sell to the client since the performance benefits were so easily understood. The client made the decision based on our estimate that the panels represented .5% to 1% of an overall $4,000,000 budget. With this hurdle cleared we then committed fully to the use of the ICBP's.

This story is not without incident the rest of the way. During our CD phase we suffered a period of about three days when we realized we still didn't fully comprehend the three- dimensional details of the product system. Up to that point we had relied heavily on the two dimensional drawings that had been in the literature from the manufacturer which seemed easy enough. However, when we got into detailing of the interfaces, the opening flashings, the base flashings, etc, we started to get a little nervous that there might be some holes in the system. To their credit the manufacturer had not only considered the finer points of the detailing, but also had written and graphic installation instructions including isometric details. They were very reachable and involved making what is always a difficult time a little easier on the project manager and his team. So the documents were completed and issued and it was on to the pricing phase; in this case a hard bid among five invited GC's. Again to their credit, the manufacturer was very involved. As promised they made a trip to Findlay to meet with bidders, answer questions and offer support regarding their scope of work. As a back-up plan we had offered an alternate to the bidders to go with our traditional wall section as the substrate for the masonry. It was interesting to see when the bids came in that even though the ICBP work was proprietary and carried with it a single material cost for all bidders, we received a wide range of bids on the multi-component alternate with a spread from $20,000 lower to $20,000 higher versus the ICBP system. For us this meant two things: that none of the bidders exceeded the premium estimate we had given the owner and that at least some of the bidders may have understood the panels to be not only a labor savings but a material savings as well. It was our good fortune that the eventual GC was on the side of seeing the panels as a savings which made the alternate a non issue for the client.

The winning GC, Clause Construction, chose to self-perform the work of buying and installing the ICB's. To their credit, their investigation of the system and understanding of the benefits led them to the conclusion that the system would be less expensive than its multi-component counterpart. A mock-up panel was specified and aided in the training process to help all parties gain a clear understanding of their scope of work. During this time the manufacturer was on site to help with training and questions. A water test similar to AAMA 501 was conducted on the mock-up and the installation passed the test the first time with no remedial work needed. In our experience the mock-up panel had always failed initially and served notice to the trades that more attention to the details and more care on the installation were going to be needed. While the crews for this project struggled a little during the first few days, it was a welcome change of pace for everyone involved to have the learning curve overcome so quickly. As it turned out the entire 11,000 sf of panel area was completed in 14 working days allowing the GC to turn the wall over to the mason quickly. The transition between trades was smooth and the work was easily completed and of a high quality. By the time the installation was complete the GC had become a big fan of the system and in fact has made inquiries directly to the manufacturer to use the system on another of their projects instead of the more traditional wall materials. For me this was very good news indeed. While I felt comfortable with specifying the system and even better after it was installed, I am looking forward to the day when it becomes routine for architects and builders to use ICBP's as the substrate for masonry, and I encourage others to consider this system for use on their masonry projects.

Summary

The use of insulated composites as backup systems can effectively achieve the major architectural wall performance requirements as evidenced by testing and over 30 years of successful product application on buildings using similar products for the finished wall. These systems have been adapted for use as a backup behind brick veneer wall assemblies and can offer continuity to adjacent wall areas using the same panel system as a backup to other façade products. The installed systems using the insulated composite backup panels have demonstrated many benefits over other wall designs using separate components to achieve wall performance standards for air, water, thermal and vapor. One notable benefit is the labor saved and improved system quality by having the insulated composite erected by one contractor versus the multiple trades used to install the multiple component wall systems.

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