

# NFBA ATTAINS CERTIFICATION FOR 2- AND 1-HOUR FIRE-RATED WALLS

**B**eginning in the 1980s, National Frame Building Association members became major suppliers of light-commercial buildings in the marketplace. As these buildings became larger and were adopted for multi-use and multi-tenant purposes, the demand for requirements for fire-rated walls in these buildings increased. Fire separations for life safety were called for by the three major building codes then being used: the Uniform Building Code of the International Council of Building Officials, the National Building Code of the Building Officials and Code Administrators International and the Standard Building Code of the Southern Building Code Congress International. Many of the fire-wall requirements of these codes remain today in the current International Building Code. Fire walls, fire barriers and fire partitions have different purposes and requirements in the IBC (Royer & Stauffer, 2012), but all appropri-

ate NFBA-rated walls can be used for these purposes. In 1990 NFBA obtained approval of its first tested fire wall. In 2012 NFBA obtained the Underwriters Laboratories V304 3-hour fire-rated wall certification (Shirek, 2012; see **Figure 1**), and in 2013 that certification was amended to include provisions for a 2-hour and a 1-hour wall assembly (UL 2013c).

## Scope of This Article

My intention in this article is to summarize the specifications for the four certified NFBA-rated wall assemblies, provide a brief history of what influenced the construction of each and present the cost efficiencies of the most recently added wall assemblies.

## History and Specifications of NFBA's First Fire-Rated Wall (1990)

In 1990 NFBA secured its first fire-rated wall. The effort was born out of a need for a 1-hour wall for buildings placed too close

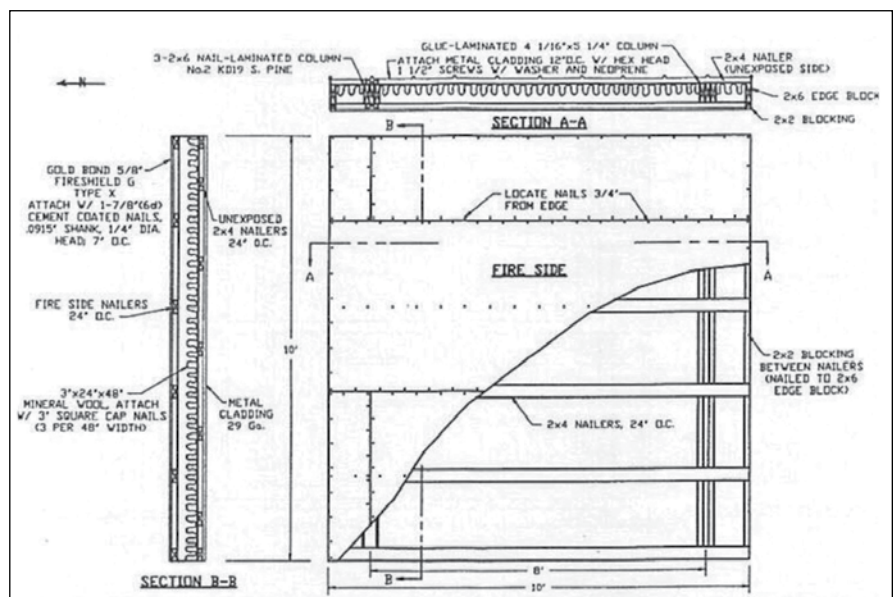
(i.e., less than 20 feet, as required in UBC) to other buildings or lot lines. The testing was performed and approval given through Warnock Hersey's testing services. **Figure 2** shows the tested construction; a detailed testing report is available on the Post-Frame Advantage website at [http://www.postframeadvantage.com/elements/pdf/NFBA\\_1-hr\\_Fire\\_Test\\_Assembly.pdf](http://www.postframeadvantage.com/elements/pdf/NFBA_1-hr_Fire_Test_Assembly.pdf).

Some key points of construction and use of the NFBA's first fire-rated assembly are listed below.

1. This is a 1-hour-rated wall with fire from one side (typically inside and unidirectional).
2. Vertical wall loads on columns are limited to 50 percent of the maximum allowable column design load (50 percent combined stress index).
3. The support columns are a minimum size of 6 x 6 or are 3-ply 2 x 6 glue-nail-laminated columns spaced at a maximum of 8 feet on center.
4. Girts at a minimum size of 2 x 4



**Figure 1.** Full-scale testing of a post-frame fire-wall assembly



**Figure 2.** NFBA's first fire-rated wall assembly

are applied on both sides of columns at a maximum of 24 inches on center.

5. A 2 x 4 vertical fire blocking is placed between the girts at all columns. This fire blocking meets the 2009 IBC requirement for horizontal fire blocking at a maximum of 10 feet (2009 IBC 717.2.2).
6. Three inches of mineral wool insulation are placed within the wall cavity.
7. The exterior wall sheathing is a minimum of 29 gauge steel.
8. The interior liner is one layer of 5/8-inch type X gypsum sheathing applied horizontally with all edges blocked. The gypsum is fastened with 1-7/8 inch (6d) drywall nails at 7 inches on center at a minimum in both perimeter and field.

A significant characteristic of this rated wall is the use of mineral wool insulation to enhance the fire resistance of the wall by as much as 15 minutes, as documented by the

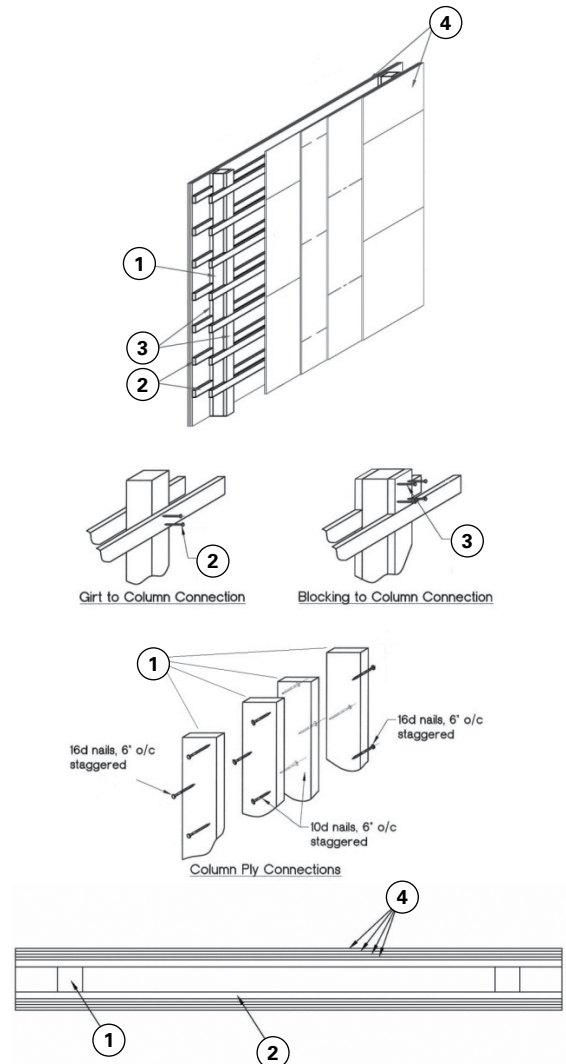
American Wood Council (2013). Mineral wool, although not commonly used in the post-frame industry, is much more resistant to fire than typical fiberglass or cellulose insulations commonly used in wall cavities. When tested, this wall assembly reached 60 minutes without fire breach or excessive temperature rise, achieving certification for a one-directional 1-hour-rated wall with a 19-minute finish rating (a common reference time at which the girt/gypsum interface reaches 325 degrees Fahrenheit).

## A Growing Need for Expansion of Fire-Rated Wall Systems

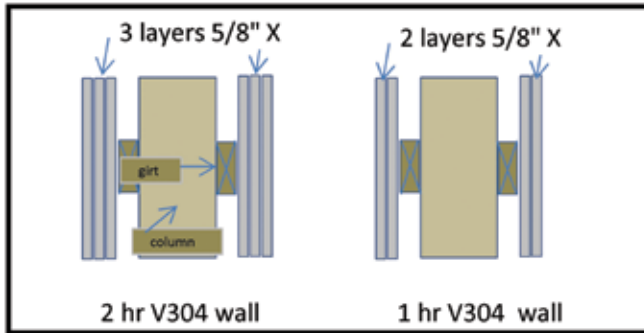
As NFBA members' commercial business grew, so did the demand for expansion of post-frame fire-rated wall systems. Larger commercial buildings with larger areas and multiple occupancies required fire walls, fire barriers and fire parti-

- ① **Wood Columns** - Min. 5-1/2 by 6 in. wood columns are constructed from min. four 2x6 in. wood studs. The column is constructed by nailing two 2x6 studs together with 10d nails spaced 6 in. OC. Staggered on opposite sides; then finished by attaching 2x6 studs to each face with 16d nails spaced 6 in. OC. staggered on opposite sides. The columns are spaced a max 96 in. OC. The columns are orientated so that the 2 in. side of each member is perpendicular to the horizontal girts.
- ② **Wood Girts** - Nominal 2 in. by 4 in. girts are applied horizontally to the face of the columns at 16 in. on center. The girts are applied with two 16d nails per column. The joints are aligned on the vertical center of the columns.
- ③ **Wood Blocking** - 2 in. by 6 in. blocking is vertically applied to the column face between each girt. The intermediate blocking is applied with four 16d, equally spaced nails per location.
- ④ **Gypsum Board\*** - **For 3 Hr Rating** - Four layers of nom. 48 in. wide by 5/8 in. thick gypsum board applied horizontally. Joints in adjacent layers are staggered a min. 16 in. Gypsum board secured to the wood girts as follows: First layer fastened with 2 in. long Type W coarse threaded screws spaced max 24 in. OC. along the horizontal edge and max 8 in. OC. along the vertical edge to the columns. Second layer fastened with 2-1/2 in. long Type W coarse threaded screws spaced max 24 in. OC. Third layer fastened with 3 in. Type W coarse threaded screws spaced max 24 in. OC. The fourth layer fastened with 4 in. long Type W coarse threaded screws spaced max 12 in. OC. All screws are offset min. 6 in. from adjacent layers. **For 2 Hr Rating** - Three layers of nom. 48 in. wide by 5/8 in. thick gypsum board applied horizontally. First layer fastened with 2 in. long Type W coarse threaded screws spaced max 24 in. OC. along the horizontal edge and max 8 in. OC. along the vertical edge to the columns. Second layer fastened with 2-1/2 in. long Type W coarse threaded screws spaced max 24 in. OC. Third layer fastened with 3 in. Type W coarse threaded screws spaced max 24 in. OC. All screws are offset min. 6 in. from adjacent layers. **For 1 Hr Rating** - Two layers of nom. 48 in. wide by 5/8 in. thick gypsum board applied horizontally. First layer fastened with 2 in. long Type W coarse threaded screws spaced max 12 in. OC. along the horizontal edge and max 8 in. OC. along the vertical edge to the columns. Second layer fastened with 2-1/2 in. long Type W coarse threaded screws spaced max 12 in. OC. All screws are offset min. 6 in. from adjacent layers.

\* Bearing the UL Classification Mark



**Figure 3.** Design V304: 3-hour, 2-hour and 1-hour post-frame rated assemblies. (See entire UL approval for list of accepted gypsum boards and manufacturers.)



**Figure 4.** 2-hour and 1-hour-rated walls added to V304 certification

tions (which require fire ratings from both sides). Other recent code changes (2009 IBC, Table 602, and 2009 IBC 705.5) requiring an exterior fire-rated wall from both sides at separation distances of 10 feet or less (versus the former 5 feet) also added to the need for economical post-frame fire-resistant walls.

With these circumstances, NFBA took on the challenge of pursuing efforts to obtain certification of a tested 3-hour load-bearing post-frame wall with fire protection from both sides that could be used for fire walls, fire barriers or fire partitions. After a successful 3-hour rating was obtained, the outlook for additional certifications was promising.

In March 2012 NFBA received UL certification for a successful 3-hour fire-wall assembly. This UL assembly testing report is located on the NFBA website at [www.nfba.org/uploads/Final\\_Updated\\_Copy\\_of\\_3\\_Fire\\_Wall\\_5-18-12.pdf](http://www.nfba.org/uploads/Final_Updated_Copy_of_3_Fire_Wall_5-18-12.pdf). In June 2013 this approval was expanded to include a 2- and 1- hour assembly consisting of the same wood-frame core construction but with reduced gypsum layers (see **Figure 3** for the approval; **Figure 4** shows the expanded ratings). Also at this same time additional gypsum manufacturers were evaluated and added to the certification to expand the availability of approved suppliers.

### UL-Tested V304 3-Hour Fire Wall: A Brief History and Specifications

Until the V304 approval, 3-hour fire walls were typically built with noncombustible framing materials. The IBC code now allows a 3-hour wall to be of combustible materials when used in a type V construction (the type of most post-frame construction). Given certain conditions and the need for 3-hour fire walls in code-compliant post-frame construction, NFBA initiated work on this endeavor. Of course IBC code also cites circumstances requiring 1- and 2-hour rated walls, and until now typical rated wood-frame stud walls have been used to meet those needs. Commonly used fire-rated designs for stud walls are UL U309, a 1-hour assembly, and UL U301, a 2-hour assembly (UL 2013a, 2013b). Given the expense of testing, the strategy of NFBA's Technical & Research Committee was to obtain a successful 3-hour rating, along with the potential of obtaining 2- and 1-hour certification through UL's "engineering evaluation" service on the basis of the 3-hour test results.

In preparation for the 3-hour fire-wall test, these points were considered:

1. When this wall is used as an IBC fire wall, as in area separations, the wall must be self-supporting to meet the intent of the IBC code requirement (2009 IBC 706.2). This fact alone makes post frame attractive because it eliminates the bracing required by most other wall types.
2. The materials used for the wall should be easily obtainable or commonly used.
3. The labor to construct the wall must not require special training, special tools or special processes.
4. Construction must allow for flexible scheduling of work surrounding the project.
5. The wall must be able to be constructed as economically as possible to compete with alternative wall systems
6. The wall must be capable of supporting all tributary vertical roof snow loads.

In order for the T&R Committee to increase the likelihood of obtaining a successful 3-hour test, preliminary sample testing was done in cooperation with the U.S. Department of Agriculture's Forest Products Laboratory in Madison, Wis. (White, 2011). A series of 11 tests was completed, leading to the final design that ultimately passed testing at UL in Northbrook, Ill., in late 2011.

### Small-Scale Test Results Drove Ultimate Design

A task group of the T&R Committee investigated the results of small-scale sample testing done through FPL to create the optimal final design. Although it was possible that large-scale tests would have given different results, the small-scale tests were excellent predictors of UL test outcomes. All sample specimens were 30 inches wide x 48 inches high in size, in contrast to the 10-foot x 10-foot specimen size required for the UL test. The key results of these tests and resulting decisions follow.

1. One obvious goal was to keep the number of layers to a minimum, so three layers of 5/8-inch type C gypsum and four layers of 5/8-inch type X gypsum were tested. Type C has more vermiculite within the core and reportedly thus holds together longer during a fire, even though its resistance to heat per unit of thickness is identical to that of type X. The sample tests found virtually no difference in the performance of the two. Type C gypsum is less available in the marketplace and is priced slightly higher. The task group did not want the UL test to fall short of the 3-hour goal; thus the four layers of the common type X recommended by FPL were used.
2. The task group investigated 2 x 6 bookshelf girts (horizontal 2 x 6 laid flatwise) versus the V304 assembly's large wall cavity with 2 x 4 girts on both sides. The FPL test results showed no performance benefit to bookshelf girts because the majority of fire resistance is provided by the gypsum. Thus the final V304 assembly used the inside and outside girts more popular in the industry, which in fact provided greater surface area (3.5 inches vs. 1.5 inches) for fastener attachment at joints, allowing for less edge cracking of dry-wall and lessening early gypsum attachment failure.

- The task group opted for a four-ply 2 x 6 nail-laminated column to increase the lumber size, which increases the fire resistance. Three-ply and four-ply samples were tested for fire resistance, with the fourth ply acting as a sacrificial laminate helping to maintain the column strength needed during the later phase of the fire test. To this end the use of 2 x 6 wood blocks for fire blocking between girts on each face of the column was incorporated to provide additional sacrificial protective wood. Incorporating the 2 x 6 blocks in this fashion meant that the IBC's fire-blocking requirement at a maximum of 10 feet (2009 IBC 717.2.2) was also met.
- Fiberglass insulation was also tested and shown to drive heat load to the

sheathing (Figure 5), forcing earlier gypsum failure yet providing a slight amount of protection to inner parts of the wood frame. This phenomenon seemed to be widely recognized by FPL. The task group recognized that certain building design walls are non-insulated, so the UL test was performed without insulation. It is incorrect, without actual testing, to assume that this type of insulation would enhance the fire-resistance time in a higher-rated wall.

### V304 Construction Specifications for 3-, 2- and 1-Hour Post-Frame Fire-Rated Assemblies

Some of the key points for use and construction of the V304 assembly are as follows:

- V304 meets requirements for a 3-, 2-, or 1-hour-rated wall with fire from either side. On the 3-hour test, a finish rating (a time measurement at which the girt/gypsum interface reaches 325 degrees F) of 2 hours was achieved.
- The wall loads applied to columns are limited to 50 percent combined stress index of the maximum allowable column design load.
- The support columns are a minimum size of four-ply 2 x 6 nail-laminated columns spaced at a maximum of 8 feet on center.
- Wall construction is a minimum size of 2 x 4 girts on both sides of columns at a maximum of 16 inches on center.
- A 2 x 6 vertical fire blocking is placed between girts at each column. These blocks enhance the fire protection of the column. (This closure of space is also required by the IBC to meet the 10-foot maximum horizontal distance for fire-blocking requirements.)
- Both sides of the 3-hour framed wall include four layers of 5/8-inch type X gypsum sheathing applied horizontally (all edges of first inside layer require wood blocking). Gypsum application is per approval drawing, with joints staggered vertically 16 inches on center and horizontally at a minimum of 16 inches. For 2- and 1-hour ratings, Table 1 gives the specifications for reduced layers.
- The fasteners for a 3-hour wall are as follows: first layer: 2-inch screw at 24 inches on center; second layer: 2-1/2-inch screw at 24 inches on center; third layer: 3-inch screw at 24 inches on center; fourth finish layer: 4-inch screw at 12 inches on center. See Table 1 for fastener size and spacing specification for 2- and 1-hour ratings.



**Figure 5.** Left: upper fiberglass-insulated cavity (30 inches wide x 16 inches high) prior to sheathing; right: tested sample showing early sheathing failure in that upper cavity.

Gypsum Layers and Fastener Length and Spacing			
Length of screw @ horizontal spacing			
Hourly wall	3-hour	2-hour	1-hour
Layers per side	4	3	2
1st layer	2" @ 24"	2" @ 24"	2" @ 12"
2nd layer	2-1/2" @ 24"	2-1/2" @ 24"	2-1/2" @ 12"
3rd layer	3" @ 24"	3" @ 24"	N/R
4th layer	4" @ 12"	N/R	N/R

**Table 1.** UL V304: Gypsum Layers and Fastener Specifications

### The V304 Fire-Rated Assembly: Frequently Asked Questions

- May I add insulation to this wall?** Yes, typical fiberglass or cellulose insulations may be added to the cavity of this wall. Because the wall was not tested with insulation, no change in approval time rating can be made.

## 2. May I adjust the column spacing?

Column spacing may be smaller than but may not exceed 8 feet on center.

## 3. May I use alternate column sizes?

Column dimension size (actual vs. nominal) may be larger in any direction but may not be smaller in either direction.

## 4. May I place columns in the ground or on a concrete wall?

Columns may be embedded in the ground set on typical footings or placed on a concrete supporting structure (e.g., a floating slab or foundation wall). Any portion of a masonry stem wall exposed above floor grade must be of an hourly rating equal to that of the V304 wall. Any portion of a column within the V304-rated wall must be of construction equivalent to the approved construction.

## 5. May I use other size girts?

Girts may be larger than 2 x 4.

## 6. May I alter the girt spacing?

Spacing of girts may not exceed 16 inches on center but may be less.

## 7. What lumber grade options are permissible?

The lumber used may be of any species or any grade. Members shall be designed to resist all appropriate roof, wind or collateral loads applicable. Note: columns must meet a maximum of 50 percent combined stress index.

## 8. Do I have to provide wood blocking on all perimeter edges of gypsum?

The first layer of gypsum must have vertical joints backed with wood blocking. The second, third and fourth gypsum layers are not required to have blocking at vertical joints. All layers' horizontal joints must be backed by the girts, typically at 16 inches on center. Note that the column blocking can serve as this blocking, but if the first-layer vertical joints do not fall at the column, the wood backing must be provided at this joint location. In all cases the 2 x 6 blocking is required at the columns and may not be eliminated.

## 9. What are the fastener options?

The size and number of fasteners may exceed but may not be less in diameter, density, or length than the approved specifications.

## 10. Do I need to finish the exposed joints with tape and joint compound?

The finishing of exposed joints is optional

UL V304 2-Hour Post-Frame Fire-Rated Wall								
	Wall length	60						
	Wall height	16						
	Layers of 5/8" fire x each side	3						
Cost category	Description	Units (sq ft)	Hrs/unit	Hrs	\$/hour	\$/unit	Total cost	% of cost
1	Columns and girts: materials cost	960	-	-	-	\$ 1.00	\$ 960	22%
2	Installation labor for frame	960	0.016	15.6	\$ 35	\$ 0.57	\$ 547	13%
3	Foundation (included in 1)	0	0.000	0.0	-	\$ -	\$ -	0%
4	Gypsum cost	5,760	-	-	-	\$ 0.32	\$ 1,843	42%
5	Gypsum handling cost	5,760	0.0026	15.0	\$ 40	\$ 0.10	\$ 600	14%
6	Gypsum fastened (no. of fasteners)	3,840	0.0028	10.7	\$ 40	\$ 0.11	\$ 427	10%
			41.301			Totals	\$ 4,377	100%
							Subtotal frame	34%
							Subtotal gypsum	66%

Table 2. Cost Analysis of Post-Frame 2-Hour Fire-Rated Wall (UL V304)

UL U301 2-Hour 2 x 6 Stud-Wall Fire-Rated Wall								
	Wall length	60						
	Wall height	16						
	Layers of 5/8" fire x each side	2						
Cost category	Description	Units (sq ft)	Hours/unit	Hours	\$/hour	\$/unit	Total cost	% of cost
1	Stud-wall frame: materials cost	960	-	-	-	\$ 0.65	\$ 624	14%
2	Installation labor for frame	960	0.012	11.5	\$ 35	\$ 0.42	\$ 403	9%
3	4' foundation (yds concrete)	7.9	N/A	N/A	N/A	\$ 140	\$ 1,106	24%
4	Gypsum cost	3,840	-	-	-	\$ 0.32	\$ 1,229	27%
5	Gypsum handling cost	3,840	0.0026	10.0	\$ 40	\$ 0.10	\$ 400	9%
6	Gypsum fastened (no. of fasteners)	7,200	0.0028	20.0	\$ 40	\$ 0.11	\$ 800	18%
			41.52			Totals	\$ 4,562	100%
							Subtotal frame + foundation	47%
							Subtotal gypsum	53%

Table 3. Cost Analysis of 2 x 6 Stud-Wall 2-Hour Fire-Rated Wall (UL U301)

and is not required for compliance.

## 11. How do I treat door openings in the 3-hour-rated fire wall?

For a 3-hour-rated wall the IBC requires door openings to be fire rated to 3 hours (2009 IBC, Table 715.4). Exposed door jambs and head jambs must be covered with a minimum number of gypsum layers applied up to the frame of the rated door (e.g., four layers of 5/8-inch type X gypsum for a 3-hour wall or the same number of layers of gypsum that the rated wall requires).

## 12. May I use a premanufactured fire-rated panel for a fire wall?

Premanufactured panel components rated at 3 hours or less (e.g., mineral wool sandwiched between steel-sheathed panels) are available in the marketplace. If these are used for an IBC fire wall, a self-supporting structural frame (see 2009 IBC 706.2, Structural stability) is required for backing. Panels are thus required on both sides, which would make their use much less economical than the V304 assembly.

## 13. Will the 50 percent load restriction

## require an increase in column size?

Although the 50 percent combined stress index structural-load requirement for columns of the V304 assembly initially seems limiting, the minimum column size specified in the approval, which was necessary to resist fire loads, generally will not mandate larger columns to meet structural load requirements.

## NFBA Secures 2-Hour and 1-Hour Rating (Amendment of V304 Certification)

The successful results of the 3-hour test afforded opportunities for NFBA to pursue 2- and 1-hour certification through either testing or a UL engineering evaluation based on the 3-hour test. One of the disadvantages of the UL engineering evaluation is that it is based on what could be considered conservative logical deduction. That said, it produces a conservative outcome but at the least cost (about \$8,000). NFBA's T&R Committee chose to obtain the engineering evaluation as a cost-effective approach rather than pursuing full-scale tests at approximately \$40,000 each. Initial review of the V304 3-hour test

Sq ft	Wall assembly	Lab hrs	Cost	Cost/sq ft	V304 cost: % of alternative
960	3-hr PF 8 layers of 5/8"	52.3	\$ 5,431	\$ 5.66	51%
960	3-hr 10" block wall	N/A	\$ 10,560	\$ 11.00	
960	2-hr PF 6 layers of 5/8"	41.3	\$ 4,377	\$ 4.56	96%
960	2-hr SW 4 layers	41.5	\$ 4,562	\$ 4.75	
960	1-hr PF 4 layers of 5/8"	38.3	\$ 3,643	\$ 3.79	109%
960	1-hr SW 2 layers	26.5	\$ 3,348	\$ 3.49	

PF= post frame  
SW = stud wall  
Costs based on 60' x 16' wall

**Table 4.** Cost Comparisons of Fire-Rated Wall Assemblies

results seemed to point to possible elimination of one gypsum layer from each side because the assembly tested to failure at 3 hours and 47 minutes. A UL engineering evaluation could not support the gypsum layer reduction without performance of a full-scale test. Thus at first glance the 2- and 1-hour certifications may appear to be conservative compared to other UL 2- and 1-hour wood-frame stud-wall assemblies (the U301 and U309 assemblies have one fewer gypsum layer on each side).

Table 1 shows the major differences in sheathing and fastening between the 3-hour wall and the 2- and 1-hour walls. The 2- and 1-hour certifications use the same wood-frame construction throughout, with changes in the number of layers and attachment density.

### Cost Efficiency of V304-Rated Walls

To analyze the costs of wood-frame gypsum-clad fire-rated assemblies, the following pricing model was used, separating cost components into six categories: (1) wall-frame material, (2) wall-frame labor, (3) foundation cost, (4) gypsum cost, (5) gypsum handling cost and (6) gypsum fastening cost (see **Tables 2 and 3**). The accuracy of this pricing model's labor categories was validated through conversations with various local contractors, including post-frame builders who have constructed the 3-hour V304 wall. The typical material and application costs in post-frame and stud-wall assemblies were compared; **Table 4** summarizes the comparisons of the wall-assembly costs. As shown, the calculated cost of a 3-hour V304 wall is 51 percent of the cost of a 10-inch block wall (Masonry Advisory Council, 2009-2010). In the summary the cost of the post frame V304 2-hour wall is 96 percent of the cost of a comparably rated 2 x 6 stud wall frequently used in the industry. A comparison of the 2-hour stud wall with the 2-hour post-frame wall reveals that the two major differences in fastener density and foundation cost contribute heavily to the advantage of post frame even though the post-frame V304 wall assembly has one more gypsum layer per side than the 2-hour stud wall (UL U301). The stud wall's two gypsum layers have 6-inch and 8-inch fastener spacing, respectively; the V304 post frame wall has 24-inch spacing on each of its three layers, which translates into less than half the total number of fasteners in post frame, providing greater labor savings in comparison to the stud wall.

In addition to the six category items noted, additional application time is saved (but not taken in analysis) with the post-frame V304 because of the ease of attachment to the 3.5-inch flat 2 x 4 instead of the 1.5-inch narrow face of the stud. In addition (not reflected in

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analysis), in the V304 assembly, elimination of the taped and finished gypsum joints required in the stud-wall assemblies also lessens labor. And last, as with all post-frame construction, greater control and efficiency are provided through use of a single-source workforce, as opposed to using multiple contractors and dealing with the resulting scheduling challenges.

### Summary

NFBA's rated fire-wall assemblies provide a great advantage for the post-frame industry. Post-frame wall assemblies provide economical 3-hour walls in comparison with masonry or light-gauge steel-frame stud walls. Post-frame 2- and 1-hour walls provide an economical alternative to currently used stud walls, which require more expensive concrete foundations and higher labor costs because of higher-density fastener requirements. Construction of post-frame walls will streamline construction scheduling and improve completion time. NFBA's accomplishment of bringing the recent new fire-rated wall systems to our industry is substantial. **FBN**

*Leo Shirek, PE, is co-chair of NFBA's Technical & Research Committee and research and development manager for Wick Buildings, Mazomanie, Wis.*