This article Reprinted from *Western Roofing* magazine, January/February 2007, Volume 30, number 1

Wood Decks

Testing Reveals Best Wood Roof Deck Systems to Resist Wind-Uplift

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(Editor's Note: Fulton Desler is senior engineer of APA - The Engineered Wood Association. He has extensive experience in the design of wood roof systems and is a member of several industry technical committees. He has been the author of journal publications in a wide variety of subjects related to wood structural panel applications. Desler may be e-mailed at: fulton.desler@apawood.org.)

New testing performed by FM Approvals (known informally as Factory Mutual or simply FM) gives wood structural panels used in commercial roof systems Windstorm Classification ratings of up to Class 1-135, meaning they resist wind-test uplift forces of up to 135 pounds per square foot. The testing enables construction professionals to specify and construct specific roof system designs that meet insurance companies' Windstorm Classification ratings for wind-uplift resistance, a critical component particularly in coastal and other high wind areas.

In 2004, FM Approvals, a research and testing arm for the insurance industry, completed wind-uplift testing for the Asphalt Roofing Manufacturers Association (ARMA). APA – The Engineered Wood Association and companies such as CertainTeed, Firestone Building Products Company, Honeywell, and Johns Manville provided the materials used in the FM tests. APA senior engineer John Rose, now retired, designed the wood structural panel decking systems and APA members provided the plywood and oriented strand board (OSB) panels used for the panel decks.

APA's new publication, *Wind-Rated Roofs*, Form G310, presents the roof systems that meet the uplift-resistance classifications of Factory Mutual and of Underwriters Laboratories, another testing organization. The Underwriters Laboratories assemblies available in the new publication are based on testing done in 1985. "We are pleased to participate in testing that furthers the collective knowledge about designing commercial roofs to withstand wind-uplift pressure," said Dr. Borjen Yeh, P.E., director of APA's Technical Services Division. "Wood structural panels provide a solid substrate to which the built-up or modified bitumen roofing is applied. When adequately attached to walls, supports and other roofing layers, plywood and OSB contribute to one of the most solid and stable roof systems available."

Plywood and OSB are light and easy to work with, making the construction process easier and more time efficient. The lightness in weight does not compromise the panels' strength; on the contrary, one of the greatest benefits of plywood and OSB is their diaphragm shear strength. In addition, wood structural panels are less expensive than other options, allowing designers and builders to pass cost savings on to the owners.

Many commercial building insurance companies are affiliated with FM Global, and the buildings they insure must meet FM standards for wind-uplift. In the Windstorm Classification rating, FM Approvals assigns systems classification ratings based on the wind-uplift pressure (not wind speeds) in pounds per square foot (psf) that the system resisted during testing, e.g., 1-90 or 1-105. By following the classifications required by the region in which the structure is built, commercial designers and builders can ensure wind-uplift resistance.

From FM *Approval Standards for Class 1 Roof Covers*, Class No. 4470, "To qualify for Class 1-60 Windstorm Classification the assembly shall withstand the effect of a minimum of

60 psf (2.9 kPa) uplift pressure for a duration of one full minute. Likewise for Class 1-90 Windstorm Classification the assembly shall withstand the effect of a minimum of 90 psf (1.3 kPa) uplift pressure for a duration of one full minute." Testing on each assembly began with 30 psf of pressure, with pressure increasing in increments of 15 psf after each minute of successful resistance until failure occurred in any component. FM Approvals assigned systems classifications based on the last successful one-minute of pressure resistance, meaning a system that failed during the 135 psf pressure test would receive a 1-120 Windstorm Classification rating.

FM Approvals tested the decking and finish systems together, but assigned classification ratings for the wood roof decking and to the base sheet/insulation/cover board/cap sheet combination separately. The wood panel decking system and the finish roofing system above the wood decks were assigned different Class 1 wind-uplift ratings based on that assessment. Based on its performance in the tests, each wood structural panel system was assigned a classification that specified maximum panel thickness, maximum support spacing, minimum nail size, and maximum nail spacing. Figures 1 and 2 show wood decking systems meeting FM classes ranging from 1-120 to 1-135. Systems meeting other classes are shown in APA's *Wind-Rated Roofs*.

Either of the wood panel systems will work with either of the finish roofing combinations shown in Figures 3 and 4. The *Wind-Rated Roofs* brochure also offers more finish roofing combinations. The overall uplift classification of the decking system plus finish roofing system will be the lower of the two system ratings. Thus, a wood deck meeting class 1-105 with an insulation/cover board combination meeting class 1-90 would be rated 1-90, or a wood deck meeting 1-105 on an insulation/cover board combination meeting class 1-120 would be rated 1-105.

"We encourage commercial designers to use FM-rated systems, even when not required to do so, for insurance purposes," Yeh said. "The structural properties of these assemblies are beneficial to building performance in any region."

It is important to note that a 2.0 safety factor is required nationwide to qualify for FM insurance coverage on any building. To be insured in an area with wind loads of up to 45 psf, the structure's roof system must be built to a 1-90 classification. Many fire-rated wood roof assemblies can also qualify for wind-uplift ratings.

Roof systems of the tested type are typically used on "flat" roofs. The maximum design uplift pressures on flat-roof systems occur at the corners of the roof. The corner pressures will often govern the selection of the roofing system design.

To better illustrate what the FM Windstorm Classification means to the building designer, Table 1 makes a simplified comparison between the wind speeds, as shown in the 2003 International Building Code, Figure 1609, and the corner uplift-design pressures. Different roof heights, configurations, the presence or absence of parapets, overhangs, terrain configurations, and building exposures will likely change the uplift-design pressures and a design professional should make the final determination as to the minimum classification required for each roof system.

Table 1
Wind Speeds and Pressures [1]

Maximum Wind Velocity[6] (mph, 3-second gust)	Corner Uplift Design Pressure (psf)	Required FM Rating
85	33	75
90	37	75
110	55	120
120	65	135

(1) Exposure B, Enclosed structure, Zone 3 of a flat roof, Height: 30'

Decks

The type of framing supports used is the designer's choice. The figures in this article depict different framing options with each figure to show the range of choices available. The spacing of the framing in relation to the wood deck is important, however, and spacing as dictated in the figures must not be exceeded to meet the FM classes listed. Framing supports must also be designed in accordance with local building code requirements for roof loads and anchorage. All wood framing must be 2 x 4 nominal or greater for plywood and OSB deck nailing.

While these deck panels shown in the following figures have passed the FM Approvals 4470 test as the bases for various finish roof systems, this does not technically constitute an FM Approval on the system. Getting a specific FM Approval is another process and the designer should check with the insurance agency for their specific requirements.

Figure 1 shows a wood deck meeting FM Class 1-120 using a minimum of 19/32" plywood or OSB 40/20 APA Rated Sheathing secured to supports using deformed-shank nails (minimum 0.135 x 2 1/8") spaced a maximum of 4" o.c. along panel edges and 6" o.c. along interior supports. Framing should be spaced at a maximum of 32" o.c.

In Figure 2, the wood deck meets FM Class 1-135. A minimum of 19/32" plywood or OSB 40/20 APA Rated Sheathing is secured to supports using deformed-shank nails (minimum 0.135 x 2 1/8") spaced a maximum of 4" o.c. along panel edges and 6" o.c. along interior supports. The sheathing is supported on framing spaced at a maximum of 24" o.c.

Insulation/Cover Boards

The insulation/cover boards fill a layer of the roof system between the wood deck and the weather-resistive roof covering. For all the FM-tested figures illustrated here, a roof covering must be applied using hot asphalt. ARMA roof coverings consist of minimum 3-ply build-up roof or minimum 2-ply modified bitumen roof coverings. The bottom sheet is mechanically fastened or is adhered to the substrate with hot asphalt. Additional sheets are adhered with hot asphalt. Consult ARMA website www.asphaltroofing.org for more information on roof coverings.

Figure 3 provides an insulation/cover board combination that meets FM Class 1-120. A layer of foam insulation, ranging between 2 and 12" thick, is adhered to the wood structural panels using minimum 3" plate fasteners applied at a maximum contributory area of 1.45 square feet per fastener (a maximum of 14" o.c.). The insulation is covered with a minimum 1/2" fiberboard cover board, adhered with hot asphalt and walked in.

The assembly in Figure 4 meets FM Class 1-135. In this assembly, a foam insulation base layer directly above the wood sheathing is optional, but a minimum of a 2"-thick composite or foam nail base is required. The maximum thickness of the optional foam insulation and the foam nail base – the total insulation thickness is 12". The nail base and optional insulation attach to the sheathing with minimum 3" plate fasteners applied at a rate of 1.45 square feet per fastener (a maximum of 14" o.c.). •••