

# Factory Mutual Ensures Structural Integrity Through Testing

By Kris Ammerman, Executive Editor, *Interface*

**T**he modern era of construction materials and installation testing began in 1953 with the Livonia, Michigan GM Transmission Plant fire. The conflagration, (involving complete collapse of the huge structure, three deaths, 15 injuries, and a \$34 million loss), served as a wake-up call for the insurance industry. Because roofs and their components can be major contributors to the spread of structural fires, it was also a warning for the roofing industry. The Livonia fire ultimately prompted the insurance industry to instigate systematic testing of roofing materials and application guidelines by manufacturers in order to approve and ultimately insure buildings constructed with their products. It also led to promulgation of more stringent standards and building code requirements.

Standard setter for scores of unrelated insurance companies, so much so that approval of a roofing system by FM carries considerable weight. It is of great import in the world of property loss prevention, and, therefore, to building owners, code officials, roof consultants, specifiers and architects, and ultimately, contractors, who must properly install the system in order to be granted FM "acceptance" at a specific insured location. In all, FM's insurance companies insure 35% of Fortune 500 companies and approximately 500,000 structures worldwide.

## Tests

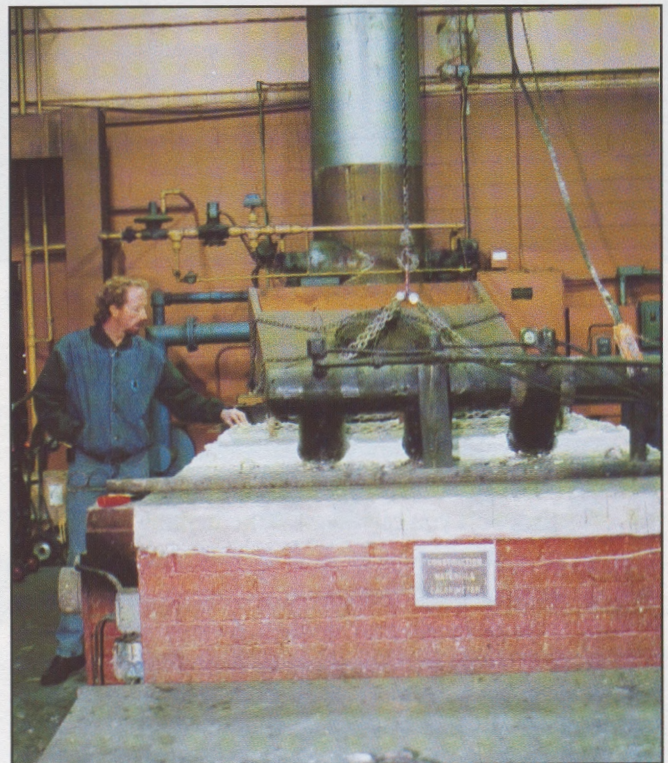
FM conducts tests on roofing assemblies at its West Gloucester, RI and Norwood, MA facilities.



*Photo 1: The ASTM E108 spread of flame test is carried out by Factory Mutual.*

There are several well-known testing agencies and laboratories which rate roofing assemblies based on their resistance to wind, fire, hail, and other natural events, as well as corrosion and general leakage. Factory Mutual, also known as FM, is the only organization that requires its approved (Class 1) systems to pass all tests—for fire, hail, leakage, corrosion, and wind.

Factory Mutual Research Corporation is the research arm of three large industrial and commercial property insurance companies—Allendale Insurance, Arkwright, and Protection Mutual. As such, it has become the stan-



*Photo 2: The original testing machine built by FM in the 1950s was the Construction Materials Calorimeter, shown here during a recent tour of FM sponsored by Region 1 of RCI.*

## Fire

Factory Mutual's fire tests analyze external fire resistance and internal fire spread.

The external fire resistance test used is the American Society for Testing and Materials' (ASTM) E108 test. An approved roof cover, insulation or deck will receive an A, B, or C rating, based on the length of propagation of flames on the tested material. The material to be tested is mounted on the cement board framework, which simulates eaves and cornices. Heat is introduced by gas burners and air is supplied by a blower. The tests cover intermittent flame exposure, spread of flame, burning brand, flying brand and the long-term effects of rain on fire resistance. (Photo 1)

The internal fire spread test results in ratings of Noncombustible, Class 1 or Class 2 (a Class 2 roof is self-propagating and does not pass FM standards). FM uses its Construction Materials Calorimeter (Photo 2) to test heat release rates for roof decks under this system. Class 1 limits are:

### Max. Avg. Rates of Fuel Contribution Btu/ft<sup>2</sup>/min (kg-cal/m<sup>2</sup>/min) by interval

3 min.	5 min.	10 min.	Test avg. (30 min.)
410 (1111)	390 (1057)	360 (975)	285 (772)

## Hail

FM-approved roof coverings must pass a hail test and be rated for either severe hail (SH) or moderate hail (MH) exposure. The test entails the dropping of steel balls of different weights through a tube onto the sampled material (Photo 3).

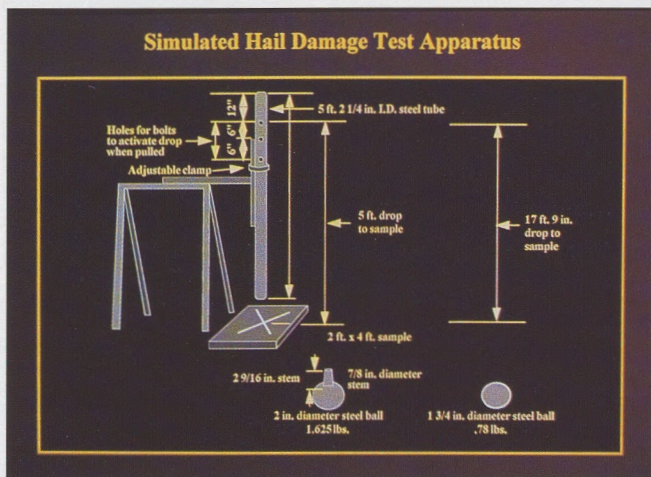


Photo 3

## Wind

Just as the Livonia fire provided the impetus for increased fire testing in the insurance industry, Hurricane Andrew, in 1992, causing nearly \$25 billion in insurance losses industry-wide, served as a catalyst for increased wind testing. As a result, FM's understanding of wind

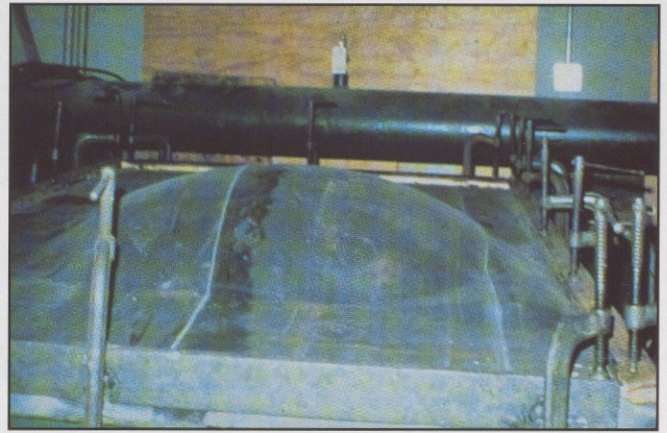


Photo 4: Delamination failure of this EPDM roof covering occurred at 105 pounds per square foot pressure.

pressurization on a building has changed.

Pressure vessels are used to test wind uplift resistance of roof assemblies. The deck is secured to the test frame; insulation, if appropriate, is then attached to the deck and the roof cover is installed. The sample is then clamped to the bottom section of the apparatus (Photo 4). Compressed air is introduced in increments of 15 pounds per square foot (psf). If, for example, the sample maintains 60 psf for one minute without damage, the assembly is rated Class 1-60. A sample failing at 105 psf would receive a 1-90 rating, the highest level at which it performed satisfactorily.

When wind strikes a building, uplift forces combine with internal building pressure to produce suction on the corners, perimeter and field of the roof. Increased pressure is experienced at roof corners and perimeters. Through studies, FM has discovered that changing the placement of fasteners in these areas can increase performance in wind uplift tests by 50% (Photo 5).

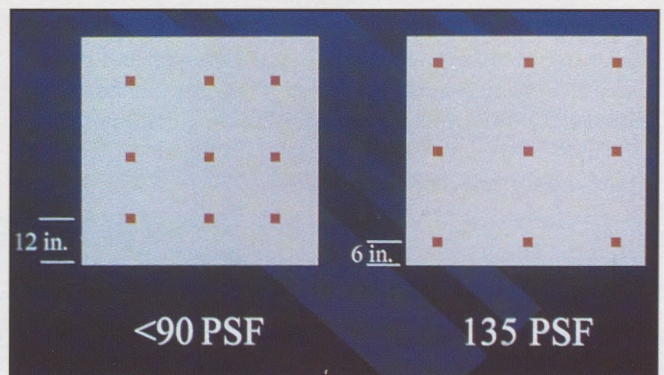


Photo 5: Changing the placement of fasteners by 6" causes a 50% increase in performance in wind uplift tests.

## Fatigue

A new machine, designed by Phil Smith, FM's Senior Engineer in Standards, Construction Division (and a member of RCI), will soon be used to test single-ply roof covering fatigue. The machine will simulate wind flutter of mechanically-attached roof membranes and be able to do

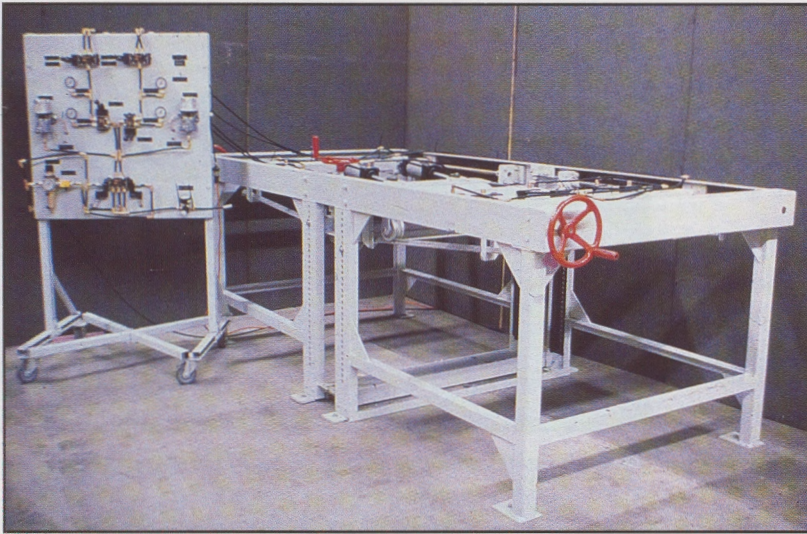


Photo 6: The new fatigue tester will evaluate long-term performance of roof covers and fasteners.

“ten years of insult in 1-1/2 days,” according to Smith’s brother George, Manager of the Materials Section, Approval Division at FM, who has also been involved in the machine’s development (Photo 6).

#### Leakage

FM uses a synthetic weathering device creating UV exposure in order to condition roofing covering samples prior to testing. The sample is placed in the apparatus and covered with 6” of water for a seven-day period (Photo 7). Twenty-five pressure cycles of 1 psig are then applied to the sample’s underside. It is then inspected for signs of leakage.

#### Corrosion

The FMRC Corrosion Test Procedure is designed to assess the potential damage to metal fasteners and plates. There is no single test procedure which approximates all climatic conditions experienced by roofing components. However, tests are available which provide an indication of potential resistance to corrosion.

Tests are conducted in accordance with the DIN 50018 Standard Test (2.0 liters) on samples prepared with fasteners installed within a minimum 22-gauge steel deck. Each sample is subjected to 15 cycles of exposure.

The fastener, and/or stress distribution plates may not show corrosion on more than 15% of the surface, and coating covering the components can not blister, peel or crack.

### Approval Guides for Specifiers and Designers

Factory Mutual publishes an Approval Guide for the materials and systems tested in its laboratories. It details each product, the level of each test they have passed, and the conditions under which the products must be installed

in order to qualify as FM-approved. Changing any aspect of the designated assembly (i.e., substrate, roof cover attachment method, roof slope, etc.), can affect performance and negate approval.

Data sheets, also published by FM, should be used in conjunction with the Approval Guide to provide general guidelines and recommendations for roof consultants and contractors in the design and installation of roofing systems.

Approval Guides and Loss Prevention Data Sheets are available by phoning FM at 617-255-4681 or visiting FM’s World Wide Web homepage at <http://www.factorymutual.com>.

Phil and George Smith will be presenting an auxiliary update program at RCI’s Annual Convention in Anaheim, CA on Thursday, March 27. Be sure to sign up to learn more about FM’s testing systems and how knowledge of such ratings can assist roof consultants in specifying and designing roof systems, and roof observers in overseeing installation of quality systems which will ultimately benefit owners and occupants of structures worldwide.

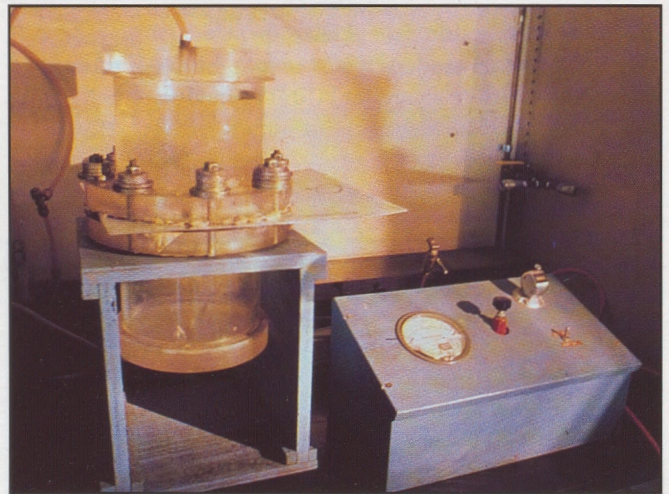
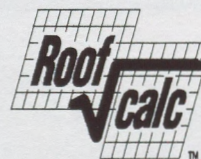


Photo 7: The leakage test takes seven days and simulates weathering.

## Roof Analysis Software



Dew Point, Energy Cost  
Comparisons and Insulation  
Pay-Back estimates.

For information fax Merik, Inc. at 770/993-8087