WOOD-SHINGLE ROOF APARTMENT FIRE
Dallas, TX
March 21, 1983

FIRE INVESTIGATIONS
NATIONAL FIRE PROTECTION ASSOCIATION

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All non-NFPA photographs have been removed from this document.
Investigation Report

Wood-Shingle Roof Group Fire
Willow Creek Apartments
Dallas, Texas
March 21, 1983

Prepared by

Richard L. Best
Senior Fire Analysis Specialist
National Fire Protection Association

In Cooperation With

Federal Emergency Management Agency/
United States Fire Administration

and

National Bureau of Standards/
Center for Fire Research
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INTRODUCTION

The National Fire Protection Association (NFPA) investigated the Willow Creek Apartments fire in Dallas, Texas, in order to document and analyze significant factors that resulted in the large loss of property due to fire. This study was conducted under a Major Fire Investigation Agreement with the Federal Emergency Management Agency/United States Fire Administration (FEMA/USFA) and the National Bureau of Standards/Center for Fire Research (NBS/CFR).

This agreement, funded by all three organizations, provides for the investigation of technically significant fires by the NFPA Fire Investigations and Applied Research Division to document and analyze incident details and report lessons learned for loss prevention purposes.

The NFPA became aware of the Willow Creek Apartments fire on March 22, 1983. Richard L. Best, Senior Fire Analysis Specialist, traveled to Dallas, Texas, to document the facts related to this fire. A three day-on-site study and subsequent NFPA analysis of the event were the basis for this report. Entry to the fire scene and data collection activities were made possible through the cooperation of the Dallas Fire Department. This report presents the findings of the NFPA data collection and analysis efforts.

This report is another of NFPA's studies of fires having particularly important educational or technical interest. The information presented is based on the best data available immediately after the fire incident and that obtained during subsequent follow-up. It is not NFPA's intention that this report pass judgment on, or fix liability for, the loss of property at the Willow Creek Apartment complex.

The assistance of Chief Dodd Miller, Assistant Chief P. M. Freeman, Assistant Chief Hickey, Fire Marshal Lambert, Battalion Chief Wells and Community Relations Supervisor William Jernigan of the Dallas Fire Department is acknowledged and appreciated. The assistance of Tom Jones, Dallas Building Official, is also appreciated.
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ABSTRACT

A group fire involving untreated wood-shingle roofing occurred in Dallas, Texas, on March 21, 1983. One of the buildings severely damaged by the fire was partially destroyed in a previous five-alarm fire in 1980.

The Willow Creek Apartments consisted of 824 housing units in 64 buildings on a 42-acre site. The fire started in an unoccupied apartment and was determined by the Dallas Fire Department to be caused by a malfunction of electrical wiring in an exterior apartment wall. The fire spread upward into the attic and advanced rapidly both internally and externally along the roof.

The fire department ordered a second alarm upon arrival and requested third and fourth alarms in rapid sequence. Flying brands from the wood shingles carried by 15- to 20-mile per hour winds spread the fire to buildings remote from the building of origin. The Dallas Fire Department controlled the fire with a five-alarm response supplemented by two special calls for equipment. Approximately 140 fire fighters manning 28 major pieces of fire fighting equipment performed fire suppression. The fire was stopped by effective use of men and equipment, including a fire department observer in a helicopter.

The apartment complex sustained losses to approximately 125 apartment units (out of a total of 824 units) in six separate buildings. The amount of loss was $5,370,000. There was no loss of life resulting from this fire.

Although the City of Dallas has an ordinance requiring fire retardant Class C roofing on new construction, this fire shows that the problem of untreated wood-shingle roofs on existing buildings will continue in Dallas for many years.
The hazard of untreated wood-shingle roofs has been recognized by NFPA for several decades. Numerous multi-million dollar conflagrations and group fires in which untreated wood shingles and shakes were a contributing factor have been recorded and reported by NFPA and the Association has campaigned for many decades for legislation banning the use of untreated wood-shingle roofs.
BACKGROUND

The Willow Creek Apartment complex, located at North Central Expressway and Walnut Hill Lane, consisted of 824 housing units in 64 buildings, covering 42 acres of land. The complex was built in stages beginning in 1967 with other phases completed through 1971. The majority of buildings were arranged around eight courts. An area of retail stores was located at the southeast corner of the development. See Figure 1 on page 16.

The apartment buildings were of two- and three-story wood frame construction. Some units had parking facilities underneath the building and those units had sprayed fiber fire protection applied on the structural steel framework underside of the floor assembly between the parking garage and the wood frame structure above. Roofs were covered with untreated wood shingles. The shingles were fastened to spaced sheathing boards similar to wood strapping or furring strips that were nailed to the roof rafters. The sheathing boards were spaced the width of the shingle courses; there was no solid roof decking. The siding of the buildings was both stucco and wood-shingle.

Building separation was typical of well-landscaped apartment buildings, with a putting green, swimming pools, streets, and courtyards between buildings and building complexes. There was an estimated 20 to 30 foot space between those buildings not separated by streets. The distance between building complexes across streets or courtyards was an estimated 100 feet. Access for fire fighting was poor because of the sloped landscaped areas, a small lake, and trees and shrubs between buildings.

Fire hydrants were located at the entrance to each courtyard and elsewhere throughout the apartment complex. Fire lanes were also established within the Willow Creek Apartment streets and courtyards. The buildings were not
equipped with standpipe systems and were not sprinklered. Fire rated partitions were reportedly installed in attics to sub-divide those spaces, but the construction, spacing, and integrity of the partitions were not determined.

Public Protection

The Dallas Fire Department was operating 49 fire stations housing 49 engines, 22 aerial ladder trucks, four manpower squads, four booster pumps, in addition to crash, rescue, intensive care units and reserve equipment at the time of the Willow Creek fire. The department had an authorized strength of 1,514 uniformed and 106 non-uniformed personnel encompassing fire fighting, emergency medical services, fire prevention, and administration responsibilities.

Weather Conditions

At the time of the fire, the temperature in Dallas was 39°F, the relatively humidity was 52 percent, and the wind was 20 mph from the north-northwest, changing to 16 mph from the northwest. The humidity was lower than normal for Dallas in March. Weather conditions during the fire were as follows:

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature</th>
<th>Relative Humidity</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m.</td>
<td>36°F</td>
<td>52 percent</td>
<td>20 mph, NNW</td>
</tr>
<tr>
<td>9:00 a.m.</td>
<td>36°F</td>
<td>52 percent</td>
<td>16 mph, NW</td>
</tr>
<tr>
<td>10:00 a.m.</td>
<td>39°F</td>
<td>46 percent</td>
<td>18 mph, N</td>
</tr>
</tbody>
</table>

Previous Fire

A previous major fire occurred at Willow Creek Apartments on August 18, 1980. The five-alarm fire originated in Apartment 102 on the lake side of Building 11. The point of origin was an upholstered chair in a bedroom. The flames spread out of the ground-level apartment, up the wood-shingle siding and ignited apartments on the two upper levels.
The roof on the north end of Building 11 was destroyed in the 1980 fire. Loss in that fire was $280,000 to the building and $132,000 to the contents of approximately 21 apartments. Some of the roof area and apartments that were destroyed in the 1980 fire burned again in the 1983 fire.

Building Code Requirements

The City of Dallas enforces the 1982 Uniform Building Code with local amendments. The Dallas City Council responded to fire department recommendations and amended the Dallas building code in 1979 to require fire retardant wood-shingles on newly constructed houses and apartment buildings.

The City of Dallas amendments to the Uniform Building Code require wood shingles and shakes to be Class C* rated on all new roofing of single-family and apartment buildings and also for re-roofing and repairs of more than 50 percent of existing roofs. The requirement for fire retardant wood shingles was implemented on April 1, 1980, following a grace period. The new amendment required that Class C rated wood shingles or shakes be used for repairs to the roof of Building 11 following the August 1980 fire at the Willow Creek Apartments if more than 50 percent of the roof were damaged. A Dallas building official stated that he had no definite information whether or not fire retardant shingles were used for repairs to the roof of Building 11. It was not determined if the damage to Building 11 was more or less than 50 percent.

*Fire retardant classifications for various roof coverings are based on tests arranged to provide three levels of severity. Successful coverings are rated Class A, B, or C with Class A passing the most severe exposure, Class B intermediate, and Class C the least severe.
THE FIRE

Smoke and then fire at Willow Creek Apartments were first observed at the center complex of buildings surrounding Willow Hill Court. Smoke appeared from the eave area at the junction of the exterior wall and roof at the west end of Building 10 outside of a second floor apartment. The apartment was not rented or inhabited at the time the fire started. The fire was reported to the Dallas Fire Department at 8:38 a.m.

Engine 22, Booster 22, Engine 37, Truck 37, and a Battalion Chief responded to the location, reported to be Walnut Hill Lane and North Central Expressway. The crew of Engine 37, coming in on Walnut Hill Lane to Weeping Willow Drive, could see smoke and they determined that the fire was near the east end of Willow Stream Court. (See Figure 2.) Engine 37 was on the scene at 8:43 a.m.

The first arriving company officer (on Engine 37) ordered a second alarm and directed all first alarm companies to Willow Stream Court. Engine 37 laid a 5-inch line from Weeping Willow and fire fighters advanced their super booster line* to the attic of Building 10 to stop the fire's westward extension. Truck 37 immediately followed Engine 37 onto Willow Stream and set up their ladder pipe to cover the roof of Building 10 and to protect the south end of Building 9. They could not get the apparatus east of Building 38 and had to operate the ladder pipe over the roof of that building to reach the fire. Engine 37 pumped two 3-inch lines to supply Truck 37's ladder pipe.

Battalion Chief Wells arrived shortly after Truck 37. He responded to Willow Hill Court and observed Building 10 well-involved with two-thirds of

*A 2 1/2-inch line reduced to a 1 3/4-inch handline with automatic nozzle.
the roof in flames, fire on the second and third floors, and the roof of Building 7 beginning to ignite. The second alarm had already been ordered and Chief Wells called for third and fourth alarms. The second alarm was transmitted at 8:43, the third alarm at 8:45 a.m., and the fourth alarm at 8:47 a.m. Battalion Chief Wells commanded the fire from the north side and ordered the third and fourth alarm companies to attack from the south.

A 1 1/2-inch line was advanced from Booster 22 at Willow Hill Court, north of the fire, to the third floor of Building 10 to attempt to cut off the eastward travel in the attic. The roof caved in, forcing the fire fighters to retreat and to abandon their line. A second 1 1/2-inch line was advanced to continue the task.

Engine Company 22 responded to Willow Stream and laid a 3-inch line from Willow Vine Court. They placed a 3-inch line wyed to two 1 3/4-inch handlines between Buildings 10 and 7 to attack the fire on the south wall of Building 10 and roof of 7. One section of 3-inch hose burst and, before it could be replaced, the company was forced to abandon the roof of Building 7. Squad 42, the last company on first alarm, reported to Willow Stream Court to assist the rest of the first alarm companies at Buildings 10 and 7.

The Chief of Battalion 7 responded on second alarm and was instructed to command the south side on Willow Lake Court. The fire was traveling rapidly across the rooftops in a southerly direction. An attempt was made to coordinate resources and prevent further extension of the fire in the southerly direction. The first priority was to set up a ladder pipe near Building 7 and as near as possible to Building 6. Truck 57 arrived just after 9 a.m. on Willow Lake Court and was assigned to set up their ladder pipe at Building 7. Engine 55 responded to Building 7 and its crew reverse-laid and supplied a 2 1/2-inch handline and a 2 1/2-inch line wyed to two 1 1/2-inch lines.
Engine Company 27, next in on second alarm, was ordered by Battalion 7 Chief to come in on Willow Lake and supply two lines: one 2 1/2-inch line from Engine 55 to Truck 57's ladder pipe, and a 3-inch line wyed to two 1 3/4-inch lines to protect Buildings 6 and 7. Engine 41, also responding on second alarm, laid a 5-inch line from the hydrant at Willow Vine Court and Weeping Willow to the west flank on Willow Stream Court. They advanced their super booster with 300 feet of additional 3-inch hose to prevent extension of the fire to Building 8 on the west side of Willow Lake Court.

Squad 8 responded on second alarm and assisted the companies on Willow Lake Court and Willow Green Court, the south sector of the fire, in manning and advancing hose lines. Truck Company 41, responding on second alarm, was ordered by Battalion 2 Chief to ladder Buildings 10 and 7. Their ladder pipe was used later on Building 10.

Engine 2 responded on the third alarm and laid three 3-inch lines on Willow Lake Court, one to Building 7 and the other two to supply Truck 57's ladder pipe. Engine 57, responding on third alarm, laid a 5-inch line from Walnut Hill Lane and Weeping Willow to the Willow Lake sector and supplied water for Engine 2, Engine 55 and their own 2 1/2-inch line and super booster line.

The crew of Engine 35, responding on third alarm, was directed by Battalion 7 Chief to reverse-lay two lines, one 2 1/2-inch line to Buildings 10 and 11 and a 2 1/2-inch line wyed to 1 1/2-inch lines to protect Building 4.

Assistant Chief Freeman arrived at approximately 9:07 a.m., ordered a fifth alarm and assumed the overall command. The fire was divided into four sectors to better coordinate the containment and extinguishment of the fire which extended across several buildings, courtyards, and
thoroughfares. These sectors were Willow Hill Court, the east side of Building 11, Willow Lake Court and Willow Green Court.

Engine 17 responded on fourth alarm and laid one 2 1/2-inch line to Building 10, one 2 1/2-inch line wyed to two 1 1/2-inch lines to the rear of Building 3 and one 1 1/2-inch hose lay-out to the roof of Building 2, all supplied by Engine 35. They also furnished two 1 1/2-inch lines to protect the roof of Building 5. Engine 8, responding on fourth alarm, was ordered by Command to go to Willow Hill Court and pump two 2 1/2-inch lines to supply Truck 41's ladder pipe. Engine 8 reverse-laid about 200 feet to a hydrant on Willow Hill Court and later stretched two additional 2 1/2-inch handlines into Buildings 10 and 11.

Engine 48, responding on fourth alarm, was directed by Command to advance wyed 1 1/2-inch lines to the second floor of Building 6 to protect the attic space. Engine 48 tandem pumped with Engine 35.

Engine 42, responding on fifth alarm, was directed to lay a 2 1/2-inch handline to the east side of Building 11. Engine 31, responding on fifth alarm, laid two 2 1/2-inch lines and wyed 1 1/2-inch lines to the north and west sides of Building 11 and tandem-pumped with Engine 42. Engine 10, responding on fifth alarm also, laid 1,500 feet of hose up Central Expressway service road to supply Truck 17's ladder pipe, which was being used to protect the roof of Building 2. Truck 17 responded on special call and set up their ladder pipe to protect Buildings 2 and 4.

Assistant Chief Hickey was on the scene at about 9:15 a.m. and acted as an observer from a police helicopter. He spotted a fire just starting on the roof of Building 2. The fire was on the back side of the roof from Willow Green Court where fire apparatus was located and the fire would not otherwise have been detected until too late. This fire and additional fires on the rooftops of Buildings 4 and 5 were reported. Engine 56
arrived on special call and was directed to lay a 2 1/2-inch line to protect Building 5 and to the attic of Building 4, which had become involved by fire from flying brands that had penetrated and spread beneath the wood shingles. Engine 56 laid in tandem to Engine 55.

Engine 6 also responded on special call and laid two 3-inch lines to attack the attic and roof fire in Building 4. Engine 6 attempted to reach the hydrant at Walnut Hill Lane on the east side of Central Expressway, failed, and was spliced out by Engine 1. Engine 38 responded on special call and was directed to supply a 2 1/2-inch line wyed to two 1 1/2-inch lines to Building 11 through Willow Green Court. They laid to Engine 6.

The Command van was set up on Willow Lake and Walnut Hill Lane. A second special call brought two engines and another truck to the scene so that additional personnel and equipment could be available to go into action on the southeast corner of the fire. Initially these companies were staged on the downwind corner of the complex in the event they were needed for offensive action. When it was determined that extension (by way of flying brands) of the fire was contained, these special-called units were used to relieve personnel on handlines in operation in various areas.

The fire was stopped at Willow Green Court. Building 4 was the southernmost structure to receive major damage. Other buildings at Willow Green Court, and Building 51 to the south, all had minor roof damage from spot fires.

Times of the alarms are as follows: the first alarm was given at 8:39 a.m.; the second alarm was transmitted at 8:43 a.m.; the third alarm at 8:45 a.m. The fourth alarm came at 8:47 a.m., followed by the fifth alarm at 9:10 a.m. Special calls were made as follows: Truck 17 at 9:10 a.m.
and Truck 24 at 9:50 a.m. Also, special calls were made for Engines 6, 56, and 1 at 9:35 a.m. and Engines 36, 15, and 38 at 10:01 a.m. The fire was reported out at 11:57 a.m., although it was the following day before hot spots were completely extinguished.

Damage

Four separate structures (Buildings 4, 7, 10, and 11) were severely damaged by the fire. Buildings 10 and 11 are considered as separate buildings although they were joined by walkways and were part of the complex of buildings surrounding Willow Hill Court. Other buildings were damaged to a lesser extent. Damage was typical of wood-shingle roof fires with some buildings showing no fire damage below the roof line, other buildings with the roof and top floor destroyed but nothing more than water damage to the lower floor or floors. Other buildings had spot fires on their roofs and were only slightly damaged.

In total, the Willow Creek Apartment Complex sustained loss to approximately 125 apartment units in six separate buildings. The amount of the loss was $5,370,000. There was no loss of life resulting from this fire.
ANALYSIS

Cause and Origin

The cause of the fire at the Willow Creek Apartment complex on Monday, March 21, 1983, was determined to be a malfunction of electrical wiring in an exterior apartment wall of Building 10. The fire originated in a section of aluminum wiring extending vertically within the exterior apartment wall from a baseboard wall outlet to the ceiling plate. This determination of cause was made after extensive investigation by the Dallas Fire Department Arson and Fire Investigation Division. The point of origin was in Apartment 325, which was not rented or inhabited at the time the fire started. There reportedly was no one working in Building 10 prior to the fire.

Fire Department Operations

Considering the difficulty of stopping the rapid spread of a wood-shingle roof fire, the Dallas Fire Department made an effective attack on the Willow Creek fire and managed to control the fire before it spread to the southeastern boundaries of the apartment complex. In addition to combating major fires in Buildings 4, 7, 10, and 11, the fire department extinguished spot fires on roofs or otherwise extinguished fires in seven other buildings: Buildings Numbers 2 and 3, 5 and 6, 8 and 9, and 51.

Among the factors that helped the fire fighters to stop the fire as soon as they did were: (1) recognition of the wood-shingle hazard; (2) rapid escalation of alarms to second, third and fourth alarms; (3) use of large diameter supply lines; (4) aggressive attack of roof and attic fires with handlines in addition to ladder pipes; (5) adequate water supply; (6) use of helicopter for observation.

Dallas fire fighters are all too familiar with the devastating effect that a wood-shingle roof fire can have when the right combination of fire,
wind, and proximity of other wood-shingle roofs exists. This was the case in the Willow Creek fire. Although the loss in this fire was significant, the experience, training and especially the dedicated commitment of individual fire fighters held the loss to probably half of what it could have been. It is felt that effective fire suppression activities were all that saved Buildings 2, 3, 5, 6, 8 and 51, all of which were exposed to fire and/or flying brands.

Discussion

Problems with wood-shingle roofing have attracted widespread attention in California, Texas and elsewhere in the aftermath of the Dallas fire and other recent fires in Houston, Texas ¹ and Anaheim, California ². The potential for a major conflagration or group fire involving structures with untreated wood-shingle roofs has been illustrated numerous times. Multi-million dollar fires where untreated wood-shingle and shake roofs were a contributing factor have been recorded every year for the past several years by NFPA's Fire Data Services Department (see Appendix A).

The NFPA has been concerned with the fire problem associated with the use of wood shingles and shakes as a roof covering for many decades. In the late 19th and early 20th century, major conflagrations were occurring in the United States. In many of these conflagrations, untreated wood shingles used as a roof covering were responsible for the fire spread. Dollar loss was extensive and in some conflagrations there was major life


loss. The NFPA campaigned vigorously for ordinances restricting the use of these materials as a roof covering. In more recent years there has been a considerable lessening of the problem, not because the nature of untreated wood shingles and shakes has changed but rather because of the concern for the problem by fire protection and building code groups in limiting the use of such material.

Untreated wood shingles are a fire hazard in two basic ways. First, these shingles ignite with relative ease. Then, once burning, they give off flying brands — bits of flaming and smoldering wood. These brands ignite more wood shingles and other combustible materials on which they land, further spreading the fire. Such "secondary ignitions" are known to occur as far away as a mile from the scene of the original fire.

Roofs can be ignited from lightweight fire brands, embers, and sparks. Fire starting inside a building can spread internally until it reaches the roof. With no solid roof decking, a fire will rapidly penetrate the roof where it then is fed by the shingles, which give off flying brands, in turn igniting other structures.

In 1966 Rexford Wilson presented a paper at the NFPA Fall Meeting in Los Angeles entitled, "Some New Answers to the Shingle and Shake Roof Problem." A copy of that paper is included with this report as Appendix B. The facts in this paper are still applicable today except that a successful means of treating wood shingles and shakes to allow them to pass the fire tests for Class B and C ratings has been developed and treated wood shingles are available today.

The banning of untreated wood shingles as a roof material used to leave the property owner who desired the aesthetic effect they created with no alternative. With the new treatments available, which when applied to wood
shingles and shakes permit them to pass the fire tests for Class B or Class C roof covering, the property owner in an area where Class B or Class C roof covering is permitted is left with a viable alternative. (See Appendix C.)

Chapter 5 of NFPA's manual on roof coverings, NFPA 203M-1980*, which discusses the basis for selecting roof coverings to resist fire propagation, recognizes the fire retardant treatment of wood shingles and shakes:

5-4 Wood Shingles and Shakes. Untreated wood shingle roofs have been looked at with disfavor by the NFPA for many years. NFPA statistics indicate that wood shingles have been a contributing factor in more conflagrations than any other of twenty-seven factors during the period 1901 to 1967. This was particularly true in the first half of the period, before the full impact of modern building codes which restricted the building of wood shingled roofs. If wood shingles or shakes are to be used, they should be fire retardant treated and classified. Untreated shingles or shakes should not be considered. When wood shingles or shakes are to be used, they should be fire retardant treated by a pressure impregnation process and classified in accordance with the NFPA 256, Standard Methods of Fire Tests of Roof Coverings.

For several decades the NFPA has taken the position that untreated wood shingles and shakes present such an obvious fire and conflagration hazard that they should not be permitted on the roof of any building. Untreated wood shingles have had a deplorable fire record — including many major fires in Texas and Southern California — for nearly a century. This is despite the fact that for the last seventeen years modern technology has made it possible to treat wood shingles so that they pass fire tests.

The Dallas City Council is to be commended for amending the Dallas Building Code to require fire retardant wood shingles on newly constructed houses and apartment buildings. However, thousands of existing structures

with untreated wood-shingle and shake roofs will continue the roofing fire problem in Dallas into the 1990s and even into the next century, as illustrated by the Willow Creek Apartments fire. There is no practical solution* to the problem of existing untreated wood-shingle roofs, unfortunately. Requiring a reasonably safe shingle or shake roof on new construction and for replacement roofs is admittedly a long-range solution to the problem, but at least offers a means to eventually eliminate a fire hazard that has too long endangered many communities.

*Although there are fire retardant coatings that are being advertised for use on wood shingles, there is no fire retardant coating approved by UL for use on wood-shingle or shake roof covering.
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<thead>
<tr>
<th>Time</th>
<th>Fire Reported</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>8:38 a.m.</td>
<td>0</td>
<td>Fire reported to Dallas Fire Department</td>
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<tr>
<td>8:39</td>
<td>1</td>
<td>First alarm</td>
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<tr>
<td>8:43</td>
<td>5</td>
<td>First engine on scene</td>
</tr>
<tr>
<td>8:43</td>
<td>5</td>
<td>Second alarm</td>
</tr>
<tr>
<td>8:45</td>
<td>7</td>
<td>Third alarm</td>
</tr>
<tr>
<td>8:47</td>
<td>9</td>
<td>Fourth alarm</td>
</tr>
<tr>
<td>9:10</td>
<td>32</td>
<td>Fifth alarm</td>
</tr>
<tr>
<td>9:35</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>9:50</td>
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<td>Special Calls</td>
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<tr>
<td>10:01</td>
<td>1 hr., 23 min.</td>
<td></td>
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<tr>
<td>11:57</td>
<td>3 hrs., 19 min.</td>
<td>Fire under control</td>
</tr>
</tbody>
</table>
Photo 1: Shown is the 1980 fire in which the north end of the wood-shingle roof of Building 11 and approximately 21 apartments were destroyed.
Credit: Dallas Fire Department by Freddie Spainhower
Photo 2: The same building that burned in 1900 is seen again in 1903. This view from the northeast. Credit: Dallas Fire Dept.
Photo 3: Aerial view after the fire from northeast shows damaged Buildings 11, 10, & 7. Note lake is lower left of photo. Credit: Dallas Fire Dept
by Freddie Spainhouer
Photo 5: Construction details of damaged roof can be seen. Note burn pattern on joists indicates fire burned from above not from below. Credit: NFPA
APPENDIX A

NFPA FIDO Summary Table
<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Type of Occupancy</th>
<th>Reported Property Loss</th>
</tr>
</thead>
<tbody>
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<td>Elementary &amp; Intermediate Schools</td>
<td>$ 5,040,000</td>
</tr>
<tr>
<td>1/15/73</td>
<td>Dwelling Fire, Monterey, California</td>
<td>Single Family Dwelling</td>
<td>500,000</td>
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<tr>
<td>6/2/73</td>
<td>Buildings Under Construction, Portland, Oregon</td>
<td>Apartment Complex</td>
<td>850,000</td>
</tr>
<tr>
<td>10/21/73</td>
<td>Buildings Under Construction, San Jose, California</td>
<td>Apartment Complex</td>
<td>2,000,000</td>
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<td>3/3/75</td>
<td>Dwelling Fire, Lake Forest, Illinois</td>
<td>Single Family Dwelling</td>
<td>500,000</td>
</tr>
<tr>
<td>11/22-27/75**</td>
<td>Forest Fire, Glendale, California</td>
<td>Canyon Camping Grounds (35 Dwellings Destroyed)</td>
<td>700,000</td>
</tr>
<tr>
<td>12/16/76</td>
<td>Apartment Complex, Ontario, California</td>
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<td>Brush Fire (Conflagration) (239 Dwellings Destroyed)</td>
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<td>Brush Fire (50 Dwellings Destroyed)</td>
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<td>Laurel Canyon Fire, Los Angeles, California</td>
<td>Brush Fire (24 Dwellings Destroyed)</td>
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<td>Brush Fire (Brush &amp; Dwellings Destroyed)</td>
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<td>Apartment Complex Fire, Dallas, Texas</td>
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<td>11/16/80</td>
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<td>Brush Fire (Dwellings &amp; Acreage)</td>
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<td>Capistrano &amp; Orange Brush Fire, Perris, California</td>
<td>Brush Fire (Dwellings &amp; Acreage)</td>
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<td>Business with Residential Complex</td>
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** Totals 29 Incidents $263,424,700

*Published Narrative Available
**Published Bimonthly Abstract Available

1 Large-Loss fires include those fires that caused at least $500,000 direct property loss. Business interruption losses are not included.
APPENDIX B

Some New Answers to the Shingle and Shake Roof Problem

by

Rexford Wilson
SOME NEW ANSWERS TO THE
SHINGLE AND SHAKE ROOF PROBLEM

by

REXFORD WILSON,
Field Representative

NATIONAL FIRE PROTECTION ASSOCIATION

To understand the need for new answers to the wood shingle and shake problem, it is necessary to understand a little bit about the problem itself. While much has been written and is available in print on this subject, a brief review probably would be helpful here.

In any study of the fire spread characteristics of roof coverings, what we are interested in is, of course, the exterior surface of the roof — the surface exposed to sunlight, rain, wind, and fire.¹

The combustible roof problem is not new. Many centuries ago, a king in Denmark decided that the combustible roof coverings were too much a community hazard. But 350 years passed and 13 kings reigned before the straw roof was removed from Denmark. Continental Europe followed suit shortly thereafter — about 500 years ago — by banning thatch and wood shingle roofs as unnecessary fire hazards.

Around the turn of the century, roof coverings in this country were mainly of wood shingles. The continuing wood shingle conflagrations, which destroyed a great many buildings in many great cities in this country, proved again that the combustible roof covering was an unnecessary community fire problem.

The ready ignition of untreated wood roof coverings, the rapid involvement of the roof top, the easy release of long-range flaming brands, and the ready overhead spread of these brands on the wind — these are the characteristics that enable this material to spread fire well beyond the area of initial ignition in conflagration weather. This overhead spread is something no fire department can cope with. This overhead spread is something no “green belt” can protect against. These unique characteristics make wood shingle and wood shake roofing the primary man-made cause of wide area spread in city conflagrations. There is nothing nature has or can do to equal the fire spreading ability of wood shingle and wood shake roofing. As the record clearly proves, wood roof covering is the most important factor in the size of a conflagration and in that conflagration’s control.²

In the early portion of this century, the problem became so severe that tests were devised to rate the fire retardant qualities of roofing material.

On April 29, 1926, a comprehensive report on an extensive series of independent tests on roofing, conducted at a noted Canadian university by the Committee of Roofing Materials of the Dominion Fire Prevention Association, was released. The report was “printed by authority of the Minister of Finance” of the Canadian government. It had been released only a short time when it was suddenly and mysteriously withdrawn, and vigorous attempts were made to track down each copy. Fortunately, an excerpt was already printed in the July 1926 issue of the NFPA QUARTERLY.³

The Canadian report placed roofing materials into six groups on the basis of ease of ignition and whether brands were produced. Group 6 included only those materials which “will not give protection against small burning brands or direct flame. Will produce dangerous burning brands.” In group 6, there are eight roofing samples — two of white cedar shingles and six of red cedar shingles. Wood shingles appear in no higher rated groups with other roofing, and no other roofing is classified in Group 6.

What is more important is that the tests made extensive examinations of other ways to apply wood shingles.

Note: This paper is based on an address given by the author at the NFPA Fall Conference in Los Angeles, California on November 17, 1965.
Underlayments, solid roof decks, and various combinations were tried, but yielded no significant improvement in either the ease of ignition or the flying brand problem.

One characteristic desirable in fire safe roofing is that it not produce brands or, if it does produce brands, that they not be flaming when they leave the roof and thus be unable to ignite other nearby roofs. Since flaming brands can be produced readily in certain stages of many fires, fire safe roof coverings must withstand ignition from moderate size brands.

After many investigations, a test was developed to measure the ability of roof coverings to withstand the threats of fire. This test has been adopted by ASTM, NFPA, and the UL. A roof material’s ability to resist spreading flame across its surface is measured by a spread of flame test; its ability to withstand ignition from severe exposure fires is checked by an intermittent flame test; and its ability to withstand brands is tested by a burning brand test.

Materials that meet these tests are rated Class A, Class B, or Class C depending on their relative ability to withstand ignition. A Class A roof must withstand exposure to mammoth brands that measure 12 in. by 12 in. by 2⅛ in. and weigh 4.4 lbs. Class B brands are one-quarter the size and weight of Class A brands — 6 in. by 6 in. by 2¼ in. and weigh 1.1 lbs. To obtain a Class C rating, the roofing only has to withstand a brand measuring 1½ in. by 1½ in. by 2¾ in. and weighing ¼ oz. It would take about 217 Class C brands to equal one Class A brand.

Wood shingle and wood shake roofing will not withstand Class C brand exposure and, in fact, cannot even withstand brands half this size. A properly placed brand the size of half a kitchen match will ignite most weathered wood shingle and wood shake roofs under the wind and weather conditions that encourage conflagrations. Wood shingle and wood shake roofing is the only major roofing sold today that fails any of these tests. Couple this with the fact that the wood shingle releases long-range flaming brands, and you join the many who wonder why this material is still used.

In the early part of this century, the air was filled with many flaming objects from chimney fires, outdoor burning, and fireplaces. These flying sparks and embers caused individual roof fires. In Illinois over a six-year pre-ordinance period, about one in every five building fires (more precisely, 21 per cent) was caused by sparks on wood shingle roofs. In Iowa and Indiana, it was one fire in every three (31 per cent over a ten-year period and 34 per cent over a five-year period), and in Alabama, nearly every other building fire (46 per cent over a five-year period) was so caused. With experience like this, there is little wonder that the insurance business began to penalize those owners whose buildings had wood shingle roofs.

The use of incinerators, cleaner fuels, and better designed heating systems and the prohibition of outdoor burning have significantly cut the number of ignition sources that are free to do their damage.

Accompanied by the decrease in the number of ignition sources combined with the increased use of fire-retardant roofing, prompted by the hazard, the ordinance, and the insurance differential, the “sparks on roof” cause of fire declined to about 1 per cent over a 20-year period.

The reduction in the number of roof fires and the advent of the computer in insurance bookkeeping has made the rate differential on roofing expensive to maintain. Over the last several years, many companies have dropped this rate differential — a reflection of experience, not an indication of hazard or of safety. As demonstrated in Bel Air, as soon as experience increases, so do rate differentials. It is a pure business consideration, not a public safety announcement.

By 1920, a few cities in the United States had begun to take shelter under an ordinance requiring some degree of fire-retardance of roofing material with Class C as a minimum. As the conflagrations continued, more and more cities adopted such an ordinance. Those cities gradually began to replace roofs that were damaged by burning or had deteriorated. Roof replacement progressed to the point that, just before the Second World War, this country experienced what was then hoped to be the last pure wood shingle conflagration. It occurred in Marshfield, Massachusetts on April 21, 1941.

Following a period of dry weather, a fire started in waist-high marsh grass. Flames spread rapidly before a 30 mph wind. Arriving fire crews raced along the roadside fending off flames from houses and cottages whose owners had let the attractive grass grow close to their homes. The fire fighters were successful until the fire hit broadside into the eleven buildings between Meadowbrook Circle and Roosevelt Avenue. Ten of the eleven buildings had dry wood shingle roofs. There were enough fire fighters to defend some, but not all, of the homes. Eaves, then roofs took fire.

Figure 1. A conflagration started by a single house fire.
Suddenly the fire left the marsh land and moved in overhead jumps through the built-up part of town. Flaming fallout of burning shingles leapt ahead of the overwhelmed fire defense forces. Fortunately, the fire swept toward the Atlantic Ocean. As the fire front reached the beach, the wind started to die; relief forces moved in and held the sides of the fire. In a little more than four hours, overhead fire spread had leveled 450 frame dwellings.

The similarities between this fire — the last of the old conflagrations — and the Bel Air fire — the first of the new breed — are remarkable.

A wood shingle conflagration does not require brush or grass to act as a fuse. Figure 1, a photograph of Shreveport, Louisiana, shows the devastation caused by a wood shingle conflagration in a straight residential area with no brush present. On September 4, 1925, fire started in the house across the street from the fire station shown in Figure 1. Flames spread from building to building and overhead on roofs to destroy 196 buildings.

Because of the obvious danger from this material, the men and women of about 600 cities eventually took shelter under a fire retardant roofing ordinance.

Figure 2 shows a Class A brand test in various stages from pre-ignition through the end of burning. The figure illustrates the resistance that Class A fire retardant roofing can deliver. Its retardant properties will last throughout the life of the covering. On the other hand, wood roof covering tends to become more hazardous with age.

For example, in the country club section of St. Louis, a gardener was burning leaves in the portable incinerator shown in Figure 3A, when a brisk wind came up and carried sparks to the roof of the home shown in the same figure. The roof was weathered wood shingles. By the time the fire department could control it, the fire had burned about half the roof and destroyed part of the second floor. The neighboring buildings would not have suffered this loss as they were roofed with cement asbestos (3B), tile (3C), and rough slate (3D) — all fire retardant in nature.

About 1957, the NFPA began to receive word that again many acres of wood shingle roofs were being constructed in Los Angeles and in the surrounding southern California communities. In 1958, Mr. Percy Bugbee of this Association issued a "Conflagration
Warning" with documentation showing the build-up of this material.

In his warning, published in the April 1958 issue of the NFPA QUARTERLY, Mr. Bugbee said, "It hardly seems necessary to observe that in southern California and Texas, prolonged dry spells and high winds are possible and that in these areas conflagration hazards are being re-created."

Because of NFPA concern, I was sent in 1959 to scour these areas to assess the actual conflagration potential from an engineering point of view. Figure 4 illustrates some of the problems found. It shows what the wind will see, acres and acres of wood shingles — kindling that can be readily ignited by flying brands.

My report to members, published in the October 1959 issue of the NFPA QUARTERLY, states in part, "While it is true that ignition of wood roofs is rarer than in previous days, fires do occur, and it is folly to assume they will not occur under the unfavorable conditions that breed conflagrations."

"There are three situations where the combustibility of the wood shingle and shake roofs will play a major part in the conflagration picture. In decreasing order of probability, they are fires: (1) in the brush and canyon country, (2) in the residential areas, and (3) during major disasters" (earthquake, civil riot, or nuclear attack) The 1959 report concludes:

"If wood shingles continue to be used at the rate they have enjoyed over the last five to ten years, then the certainty of a major wood shingle roof conflagration...will be assured."

We were clearly heading back into the old wood roof conflagration era.

In 1961, the first true wood shingle conflagration since the Marshfield fire twenty years before occurred in Los Angeles. The loss of a definite fire front and the loss of hundreds of buildings — both characteristics of wood shingle fires — occurred in this new fire. Just as in Marshfield, flames moved rapidly before a 30 mph wind, burning dry brush. The hard-pressed fire
defenses held until flames roared almost broadside into homes on Upper Stradella Road. The defense force was overwhelmed. Some homes were saved; several roofs ignited. That was the ballgame! Burning shingles rained down on the roofs of homes on Roscomare Road. The first home to ignite on Roscomare Road is shown in Figure 5. From these roofs, more brands were carried south into the heart of Bel Air. Note, in Figure 6, the brands in the street and on the lawn. The definite fire front was lost. Homes were burning well ahead of and outside the brush fire area. Then, without warning, Brentwood — over a half mile to the west — was hit. (See Figure 7) Flaming fallout flew over Supulveda Boulevard and the wide cut for the then new San Diego Freeway — a fairly large "green belt" — and bombarded the area. This paratrooper-like landing behind the fire defense forces started many simultaneous fires. Fire forces vectored from Bel Air fought their way into the area through evacuees. But this took time, too much time. In a little more than six hours, what we had known would happen did happen.

Figure 4. Winds-eye view of an area with combustible roofs.

Figure 6. Brands spread down canyon to shower lawn, street and roofs.

Figure 7. Combustible roofs in Brentwood, over ½ mile away, ignite.

Fortunately, the fire department conducted a complete, professional analysis of the construction, location, and damage to each structure in the area. The results revealed that, in spite of a 50 to 100 foot-wide "green-belt" between the brush and the structures, eight wood shingle roofed homes ignited for each fire retardant roofed home that ignited.11

In 1964, a situation similar to that in Bel Air began to develop around Santa Barbara and Montecito. But mercifully, the fire burned away from the city for 24 hours, before it turned and made its run into the homes. This gave fire forces, who quickly assessed the potential danger, time to gather additional strength from widely surrounding areas. It gave homeowners time to prepare their defenses and soak wooden roof tops. When the fire made its run at the city, a great many sparks and embers were released by the burning brush as shown in Figure 8. They ignited roofs, burning homes such as the one shown in Figure 9.

Does the presence of the wood shingle roof in California show up in the record as important? Since the
Bel Air fire in 1961, that is 1962 through the first half of 1965, the United States has experienced 19 conflagrations. These occurred in eight different states and destroyed more than 700 buildings. Over 300 of these buildings were lost in California alone—a ratio of six buildings lost in the State of California conflagrations for each building lost in any one of the seven other states.

We cannot bury our heads in the sand and say that there is no problem—for there is a problem. We cannot say that we can cut the wood in a different manner, or soak it in a solution, or nail it on differently and thereby automatically get rid of this difficult problem. People in California—architects, builders, homeowners—like the wood shingle, like its appearance. But to have it, they risk their own property; they endanger their neighbors next door and miles away, and, indeed, they endanger the community itself.

If Mr. X were to walk over to Mr. Y’s house, climb to the roof and ignite the roof covering, he would be arrested, and the community would be shocked by his act. If Mr. X were to do this on a very dry, windy day and do it to four houses instead of one, the public would probably be indignant and certain that Mr. X had lost his mind.

But in California, under the protection of the state and with the permission of the city, Mr. X is allowed to use the one building material that will carry ignitions to neighboring homes just as surely as if Mr. X had carried them there himself.

If these ignition sources or brands land on roofing having some fire retardance, the brands will have to be fairly large in order to cause ignition. But if these ignition sources land on wood shingle or shake roofs that can be readily ignited by brands, small embers, or even moderate-size sparks, the roof can ignite and produce its own brands—creating a chain reaction.

Men must be dispatched to each new house fire, depleting the force trying to control the first fire. If four fires are started, the need for men and equipment is even more severe. If sixteen separate fires are started, the demand may be overwhelming. (In Bel Air, the third jump, from Roscomare Road south, carried brands onto roofs of well over 100 homes destroyed in this area.)

If the roof burns so fast that additional brands are released during the time the equipment is dispatched, and responds, arrives, sizes up, commits, and gets water on the roof, then a chain reaction can continue until nature calms the fire or until the fire runs out of fuel.

Wood in the form of shingles and shakes is the one material that exhibits these fire expanding characteristics.

The question of legal liability is an interesting one. To our knowledge, there has not yet been a case in which Mr. Y has sued Mr. X for damages because his home was destroyed by a brand from Mr. X’s burning roof—a clear and known hazard.

The liability of the community is also an interesting question to ponder. Can a homeowner in Brentwood seek damage from the City of Los Angeles because it allowed the use of wood shingles in Bel Air, despite their long-proven fire spreading potential?

For over 40 years, man has been trying to find an effective solution to this problem. He has tried copper plating wood shingles; he has tried dipping them in asphalt and covering them with granules; he has tried soaking them, spraying them, and painting them; he
has even sought new methods of applying them. Unfortunately, the wood roof covering is not a material from which we can nail or paint or spray or pray away the fire problem. It is one of the tough engineering and chemical problems of the 20th century.

A city with wood shingle roofing—its kindling turned toward the sky—displays an open invitation to either natural or man-made disaster. The problem is of concern to the Office of Civil Defense in Washington, for the susceptibility of a fringe area having wood shingles on the roofs to fire following nuclear attack is severe and quite indefensible.

Two years ago, California's Governor Brown created a special study committee for conflagrations. He knew that California, which is ordinarily a state with a high sense of safety, had created a serious situation by permitting untreated wood shingles to be used as roofing. The Roofing Subcommittee is still meeting in the hopes that it can find some effective solution to the wood shingle problem.

Alternate types of materials, which are attractive and completely noncombustible, have been available for many years. Samples of these were illustrated earlier—cement asbestos, tile, and rough slate. Recently, we have become aware of several of the new materials that are being prepared in an attempt to further alleviate this difficulty. Three of these solutions are worthy of comment.

One material recently developed by a roofing manufacturer is a simulated wood shingle made of a cement-perlite material that has the flexibility, the color, and the shadow line of wood shingles and is made in random widths. The new shingle can be installed by a wood shingle roofing contractor to provide an effect almost identical to that of a wood shingle roof as shown in Figure 10. This material has an added attraction because it can be used in any area of a city in any fire zone with no difficulty, for it has a Class A fire-retardant rating. This means that it will withstand a large burning brand falling on it.

Another material, this one prepared by an aluminum company, is an aluminum "wood shake" (see Figure 11). The use of this material produces a roof that can obtain a Class B rating. This material also provides the varied shadow patterns that are so attractive to many people and can be used in many areas of the fire zones and on many different types of buildings.

I had hoped to be able to announce at this time that there is a UL labeled Class C wood shingle and shake treatment. Unfortunately, such is not the case. As you know, such a treatment has been actively sought for at least 40 years, but the expansion and contraction of wood exposed on the roof to rain and sun drives the treating chemicals out like water from a sponge.

But now, a means of hooking the chemicals into the wood has apparently been found. The company* involved has reported minor, but delaying, difficulties in

* There are three companies known to be involved with this testing, and reportedly, two others are interested. The information here comes from one company's representative.
the development of the process — I repeat, the process — not the treating chemical. As soon as these impediments can be cleared up (and it looks like they can be), it should be clear sailing. The treatment is good. It not only passes all the regular tests, but in a special check of the brand production, wind velocities were raised and no dangerous burning brands were produced. This is an important, significant advance. If all things go as they are reported, by this time next year a Class C, UL labeled wood shingle and Class C, UL labeled wood shake will be available. Such a shingle would be readily allowable under the existing fire retardant roofing ordinance.

In summary, for a great state like California to continue to give privileged status to the one material, to continue to discriminate in favor of the one material, the one material that cannot pass the relatively mild Class C Test, the one material which in burning creates a clear and present danger to the individual and to his community is rather unusual. If any other manufacturer attempted to sell some new type of roofing that would help a building burn down, there would be a great outcry. If he produced a roofing that not only permitted that building to burn, but also endangered all the neighbors on either side, there would be a tremendous reaction from building code people, from the fire service, and from the architectural profession.

California continues to shelter, under an umbrella of laws and regulations, the wood shingle and shake which can not only cause the destruction of the original house and its neighbors but also cause the ignition of roofs thousands of feet and even miles away. It can spread fire to endanger the community with its paratrooper-like landings behind the fire defense lines. The flaming fallout, so readily produced by burning brands, creates a civil defense and community fire potential that should no longer be tolerated. California, which leads the country in many of its laws and which is a pace-setter for attitude, fashion, and design, has been left behind in dealing with the ancient hazard — wood shingles and wood shakes. Fortunately, ignition sources in that state have been reduced to a point where the fire department doesn’t have 30, 40 or 50 per cent of its calls to wood shingle roof fires. Fortunately, the state has a more effective fire service, which can deliver a powerful initial punch. But on that day with the high winds, on that day with the low humidities, and on that day with the ignition, on the day that the punch is slightly delayed, the fire departments will run and run, and the citizens will join them. More wood shingle conflagrations with their tremendous building losses are bound to occur.

California must demand equal safety from all its roofing and not discriminate in favor of the one dangerous material just because it is desired or has been long used. California can no longer tolerate privileged status for wood shingle and wood shake roofing. The time for control of this unnecessary community hazard has come. The new materials that are being developed will make this control possible.

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11 "The Los Angeles Conflagration of 1961," Rexford Wilson, NFPA Quarterly, Vol. 53, No. 3 (January 1962), pp 241-288 (also available as a 46 page reprint at a unit price of $1.50*).

* Available from: Publications Department, National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts 02110.
APPENDIX C

A New Class C Treatment for Wooden Shingles and Shakes

by

Ralph H. Bescher

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National Fire Protection Association
Batterymarch Park, Quincy, MA
A New Class C Treatment for Wooden Shingles and Shakes

RALPH H. BESCHER, Assistant Vice-President
Forest Products Division, Koppers Company, Inc.

The story of the development of a satisfactory treatment for wooden shingles and shakes to qualify for an Underwriters' Laboratories, Inc., Class C label is an interesting one—a series of events and actions. It started with the Bel Air Fire in Los Angeles, which forcefully demonstrated again the hazardous nature of wooden shingles and shakes. Because of the Bel Air Fire, Underwriters' Laboratories, Inc., prepared an outline of a method of testing treated wooden shingles.²

To a manufacturer of chemicals, the UL outline defined the problem in understandable terms. If a problem can be sufficiently defined, a technical research laboratory can generally find the answer. The Monroeville Laboratory of the Koppers Company took on this assignment, and, after much laboratory investigation, the results of its tests indicated that a solution had been found.

Western red cedar shingles and shakes were processed under observation by a UL representative and were subsequently tested at the UL Northbrook, Illinois, laboratory. Tests were run in triplicate, first on untreated shingles and shakes and then on treated shingles and shakes.

The performance of the treated shingles and shakes was determined by the three standard fire tests for roof coverings—a flame exposure test, a spread-of-flame test, and a resistance-to-burning-brand test.³ These three tests were also conducted on samples that had first been subjected to the permanence-of-treatment test (the so-called "rain" test). In addition to the three standard tests, the treated wooden shingles underwent a fourth test—the flying brand test.

THE PERMANENCE-OF-TREATMENT TEST

The permanence-of-treatment test, which requires that the treatment be virtually insoluble in water, consists of exposing the roof sections to the UL rain test equipment.⁴ Twelve weeks' alternate cycles of 96 hours of rain exposure and 72 hours of drying at 140° F simulate 800 inches of rainfall over a 10-year period. Treatment is judged to be permanent if there is no significant difference between the results of the three standard fire tests run on samples "as received" and after the rain test. (Besides the laboratory rain tests, a 10-year weathering test is also being conducted.)

As will be noted below, the fire tests conducted on the shingles and shakes subject to this exposure gave results that were essentially the same as those obtained on unleached "as received" treated samples.

THE TEST SAMPLES

In all the tests the samples consisted of shingles and shakes applied to a slit-type deck made of 1-inch-by-4-inch boards spaced 1¾ inches apart. A layer of 15-pound asphalt-saturated organic felt was attached to the decks of the shake samples.⁵ The exposed surfaces of the shingles and shakes were 5 inches and 10 inches, respectively; there was ¾-inch spacing between adjacent shingles and shakes.

THE FLAME EXPOSURE TEST

The 4½-foot-long-by-3¾-foot-wide test deck is mounted so that the long dimension inclines 5 inches

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² Outline of Proposed Investigation of Factory-Treated Wood Shingles (Class C), Subject 398, Underwriters' Laboratories, Inc., November 1962 (revised December 1963).
⁵ Any weight of asphalt-saturated organic felt heavier than 15 pounds is permitted and meets UL requirements.
to the horizontal foot. A 12-mph wind blows up the deck, and a gas burner the width of the test deck and located behind the lower edge of the sample is adjusted so that the flame covers the exposed surface of the deck and extends from 1 to 2 feet beyond the upper edge of the sample. The temperature of the gas flame is 1,300° F ± 50° F. The flame is applied for three 1-minute periods, with 2-minute off periods between applications. To pass the flame exposure test requirement for Class C roofing, 1) no portion of the covering may blow or fall off the deck as flaming or glowing brands, 2) the deck may not become exposed, 3) portions of the deck may not fall away, and 4) the roof covering must protect the combustible supporting deck from sustained flaming.

In the test on untreated shingles surface ignition occurred at 28 seconds, and at 45 seconds the surface flaming had extended to the top of the deck. Sparks were blown from the deck at 45 seconds, and at 2 minutes, 35 seconds the underside of the test deck ignited and sustained flame. Figure 1, left side, is a typical result of the flame exposure test on untreated shingles. No flaming occurred on either the shingle surface or the underside of the test decks during the tests of treated shingle samples (Figure 1, right side).

In the test of untreated shakes (Figure 2, left side), surface ignition occurred at 35 seconds and flaming had extended to the top of the third course of shakes at 60 seconds. Sparks were blown from the deck. Sustained flaming on the underside of the deck started at 2 minutes. During the tests of the treated shakes (Figure 2, right side) there was no sustained flaming, either on the shakes or on the underside of the test deck.

Figure 3 shows the results of flame exposure tests run on treated shingle and shake samples following rain tests. At no time during these tests was there flaming on the surface or the underside of the decks.

THE SPREAD-OF-FLAME TEST

This test differs from the flame exposure test in that the test deck is 13 feet long and the exposing gas flame is applied continuously for 4 minutes. The first three qualifications for a passing test were the same as for the flame exposure test. The fourth and fifth conditions were that the spread of flame on the surface must not extend to the top of the 13-foot-long sample during the 4-minute flame application, and that there be no signifi-
In the test of untreated shakes, flames were first noted at 46 seconds. In 3 minutes, 44 seconds, flames had extended to the top of the 13-foot sample (Figure 5, left). No brands were blown from the sample, but at the conclusion of the test there were several loose brands on the surface, and they could have been blown away had the wind been stronger. The maximum surface flame spread in the tests of the treated shakes was 1 foot (Figure 5, right side).

THE RESISTANCE-TO-BURNING-BRAND TEST

The 4¼-foot-long-by-3¼-foot-wide deck for this test is mounted on an incline of 5 inches to the horizontal foot with a 12-mph wind up the deck. At one-minute intervals 25 Class C burning brands* are placed over joints between shingles or shakes and just below the butt of the course above. To pass the test, not more than five of the 25 brands may cause sustained flaming of the dry white pine deck boards. Also, the burning of the material being tested should produce no glowing or flying brands.

In the test of the untreated shingles (Figure 6, left side) sustained burning of the underside of the test deck occurred beneath 23 of the 25 brands applied. No flaming of the deck boards was noted during the three tests of the treated shingles, although the shingles were ignited by four brands (the flames went out when the brands diminished in size).

* A Class C brand is kiln-dried white pine 1% by 1% by 25/32 inches thick. One saw kerf ¾-inch wide and half the thickness of the brand is made across the center of the top, and another is made at right angles across the center of the bottom. The dry weight is 9% ± 1% grams. There is a 2-minute preburn before the burning brand is placed on the deck.
Eleven of twelve brands placed on untreated shakes ignited the underside of the test decks. In tests of five decks of treated shakes, 74 brands were used. flaming of the deck boards occurred in two cases. Figure 7 shows results of the shake tests.

Burning-brand tests were also run on treated shingles and shakes after the rain test. There were no ignitions of the underside of the deck in the shingle test (Figure 8, left). One of the 14 brands applied to the shake sample ignited the underside of the deck (Figure 8, right).

THE FLYING-BRAND TEST

For the flying-brand test, the 4½-foot-by-3½-foot deck is mounted on an incline of 5 inches to the horizontal foot and a 12-mph wind blows uniformly over the inclined surface from the bottom edge to the top. The deck is exposed for 4 minutes to the same test flame as in the flame exposure test. After the 4 minutes of flame application, the 12 mph wind is allowed to blow on the wooden shingle samples (the wind is increased to 18 mph for shake samples), until surface flames go out, or the surface of the supporting deck ignites, or flying brands are produced. If brands are produced before the surface flames go out or the supporting members ignite, the test indicates a failure.

Figure 9 shows untreated (left) and treated shingles following the flying brand test. In the test of untreated shingles, 1-inch-by-1-inch brands were noted one minute after the test flame was shut off. After two minutes there were 6-inch-by-6-inch brands. The treated shingles produced no brands.

Brands ranging in size from 2 inches by 2 inches to 6 inches by 6 inches were blown from the untreated shake deck (Figure 10, left side) after the test flame was shut off and the wind velocity was increased to 18 mph. During one of the three tests of treated shakes there was surface flame (Figure 10, right side) that ignited the underside of the deck 4 minutes, 35 seconds after the test flame was shut off. However, no brands were produced.

The flying-brand test was applied to treated shingle and shake samples that had undergone the rain test. Figure 11 shows the results. During the test of the shingle deck (left), flaming occurred at a joint in the second course, and 2½ minutes after shutoff of the test, flame had ignited the underside of the deck. This burning was allowed to continue for about 10 minutes, during which time severe flaming involved five deck
boards. No brands were produced or blown from the deck.

No surface flaming was noted during the 4-minute test flame application to the “rain”-exposed shakes (Figure 11, right). The test flame was rekindled at 4 minutes, 13 seconds; at 5 minutes, 30 seconds the first course of shakes ignited. Fire spread to the second course, and at 9 minutes, 50 seconds the underside of the deck boards ignited.

Commenting on these flying-brand tests, the report of Underwriters' Laboratories states:

It is significant that in the flying-brand tests with treated-wood shingles and shakes, which had been subjected to the 12-week rain test, no flying brands developed during the test, even when it was continued to a point where the test deck began to fall apart.

**COMPARISON OF THE COSTS OF ROOFINGS**

As is shown by the four tests summarized here, a satisfactory treatment has been devised for the safe use of wooden shingles and shakes. The accompanying table indicates that the treated products are in a satisfactory competitive position as far as price is concerned. However, the treated shingles and shakes are more expensive than the untreated, and the motivation for using them will come primarily from the law, to protect built-up areas.

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**Average Applied Price, Nationwide**

<table>
<thead>
<tr>
<th></th>
<th>Average Price Per Square Applied</th>
</tr>
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<tbody>
<tr>
<td>Asphalt Shingles — Class C</td>
<td>$ 20–25</td>
</tr>
<tr>
<td>Asbestos Shingles</td>
<td>25–30</td>
</tr>
<tr>
<td>Wooden Shingles — Class C</td>
<td>40–50</td>
</tr>
<tr>
<td>Wooden Shakes — Class C</td>
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<tr>
<td>Porcelain Enamel Shingles</td>
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