IBHS RESEARCH PROJECTS 2025

Transforming Science into Practical Solutions

ROOF AGING FARMS

Roof Aging Farms & the Path Forward

Currently, a substantial segment of building science explores novel materials and systems, but it often overlooks the repercussions of **decay and wear caused by severe weather conditions, prolonged exposure to solar radiation, especially ultraviolet rays, and temperature fluctuations**. Recognizing this research gap, IBHS launched a comprehensive asphalt shingle aging initiative in 2013, with specimens subjected to testing at pre-defined intervals (5, 10, 15, and 20 years). In 2025, IBHS will harvest and begin testing the second set of 10-year samples from the IBHS and Member farms to **further understand the effect of aging on asphalt shingle performance across different geographic regions of the country**. IBHS will continue its annual assessments of all farms and produce a summary of the findings for Members.

In addition, the scope of the aging farm will be expanded:

1. IBHS will begin **aging roof specimens for field deployments to expose them to real hail events** for comparison to damage modes observed in the laboratory.
2. Installation of additional **new and innovative roofing products featuring emerging technologies**, such as composite/synthetic products and those with coatings (e.g. GoNano, which was added as a product in late 2024).

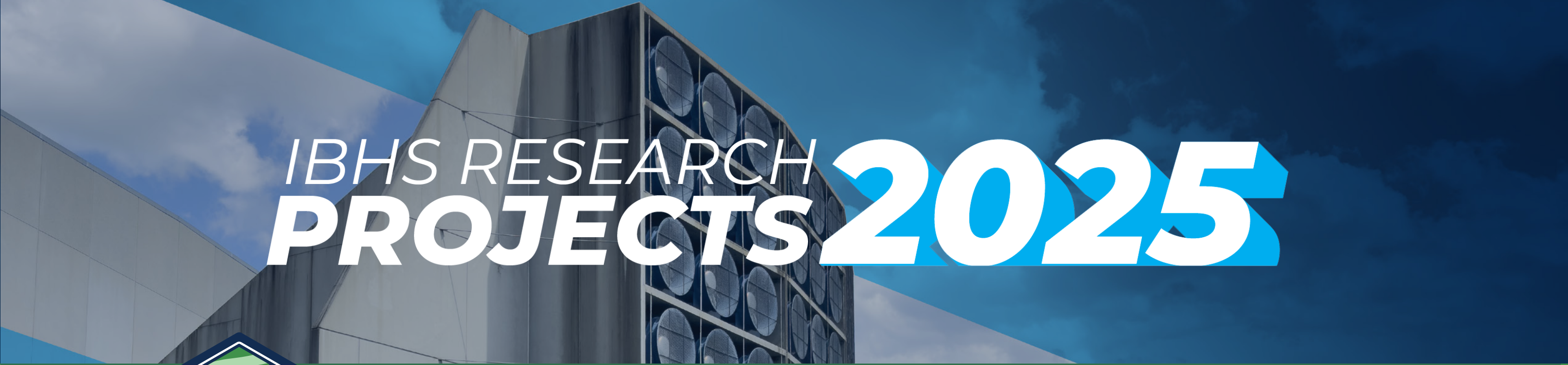
IBHS RESEARCH PROJECTS 2025

WIND RESEARCH

Wind Performance & Reliability of Steep-Slope Roof Covers

The wind performance of asphalt shingles—as they age—remains one of the most difficult and important challenges IBHS faces in its research program. IBHS will continue a multifaceted approach to **understanding what leads to failures of shingles in wind environments far below their design standards**. This includes:

- **Contrasting the wind performance of asphalt shingles to other types of roof covers**, including emerging materials like synthetic composite shingles, in support of the Roofing Roadmaps initiative outlined in IBHS's *Strategy26*.
- Continuing small laboratory experiments to guide whether **new test protocols are needed or if existing standards can be modified to properly account for the systemic unsealing** that occurs with asphalt shingles. This includes assessing the accuracy of the current model for maximum loading on asphalt shingles and sharing the findings.
- Performing reliability analyses on steep-slope roof covers using wind load information derived from a 2023 full-scale chamber experiment. This approach provides a **realistic metric for assessing the true wind performance** of roof cover materials and improves on the methods utilized by current standard test methods.
- **Quantifying the unsealing of asphalt shingles** on IBHS and Member company roof aging farms to examine the scope of the problem and possible climate influences.
- Performing data analytics research to:
  - **Understand performance differences** between hurricane-prone regions and areas that experience primarily severe convective storms.
  - **Determine expected lifespans of asphalt shingle roofs** in the different wind (and hail) climates across the United States.
- Conducting exploratory research using our thermal conditioning system and accelerated aging chambers to try to **mimic natural asphalt shingle heating and cooling cycles** that are hypothesized to weaken and degrade asphalt shingle sealants over time.
- Continuing research using Component Materials Evaluation Testing (COMET) to investigate the **reduction in asphalt shingle sealant strength** across the duration of a wind event and assess the influence of shingle "lip" height on pressure coefficients.



IBHS RESEARCH PROJECTS 2025

WIND RESEARCH

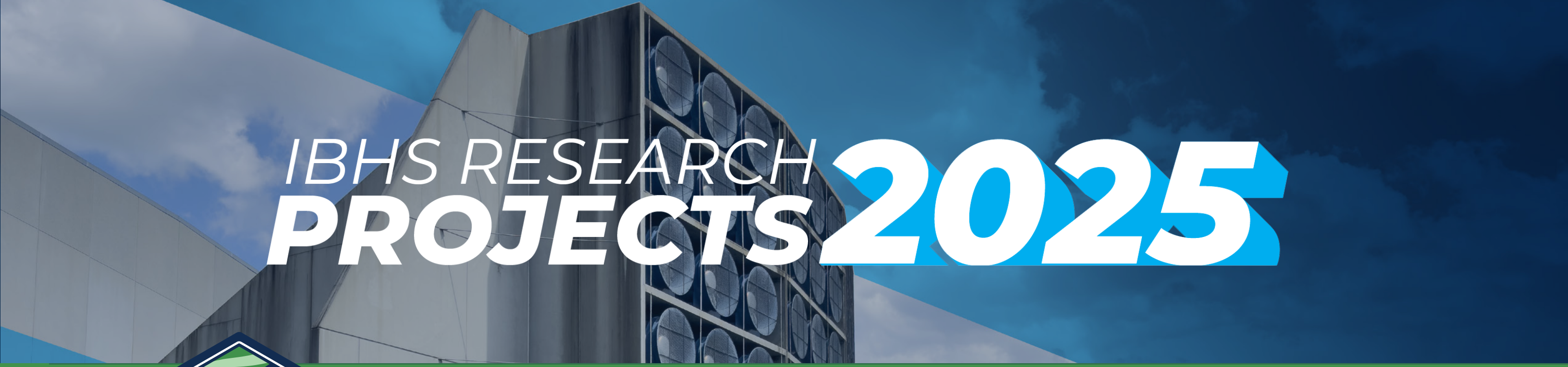
Wind Performance of Commercial Roofs

Since 2021, IBHS has studied the vulnerability of commercial membrane roofs in high winds based on failures observed in the lab and during post-event assessments in the field. In 2021, full-scale testing revealed that internal pressures can transfer wind loads through the roof assembly to the membrane itself. Additional full-scale testing in 2023 and 2024 analyzed how mechanically attached and fully adhered membranes responded under wind loading, given the different load paths in each of these configurations, and looked at the effect of internal pressure on those membranes. **IBHS observed that for fully adhered membranes, the membrane was less likely to be displaced, which caused loads to be transferred back down through the assembly potentially leading to failures elsewhere**. These observations will be investigated further in 2025 utilizing IBHS's pressure loading actuator (PLA) system. The outcomes of full-scale tests will be compared to outcomes of the UL 580 standard testing with the goal of verifying whether smaller roof specimens (10 ft x 10 ft in the case of UL 580) yield similar failure modes given the same load recorded.

Fundamental Improvement of Codes & Standards

ASCE 7 provides basic wind loads for use in the International Residential Code (IRC) and International Building Code (IBC), which form the basis of building codes adopted by local jurisdictions. In 2015, IBHS successfully updated the components and cladding loads for flat roofs in ASCE, which had not been updated since the early 1980s. However, loads for walls remain unchanged due to a lack of sufficient experimental data. In 2024, new proposals were developed for the main structural loads on buildings which required the increase of the loads on building components such as roof and wall covers. While changes were made to the components' loads for walls and steep roof slopes to ensure consistency with the structural loads, there was insufficient data to fully correct the wind loads on these building components, which have been known to be inadequate for more than 20 years. In 2025, IBHS will undertake a significant wind load study in collaboration with Western University in anticipation that it will result in the wind loads in building codes better reflecting the true loads these components experience.

IBHS's post-storm assessment of building performance following Hurricane Ian revealed surprisingly poor performance of membrane and built-up commercial roofs. Many of these damaged roofs also had visible damage to flashing and/or coping despite a specific standard adopted into the Florida Building Code (ANSI/SPRI ES–1). It is unclear if the standard itself is deficient, or if these failures are related to its application or perhaps the ability to inspect for it. As an extension of IBHS's ongoing full-scale testing program focused on low-slope membrane performance, throughout 2025, researchers will explore whether changes to the associated code provisions and standards for membrane roofs are needed.



IBHS RESEARCH PROJECTS 2025

WIND RESEARCH

Wind Damage Amplifiers

In a 2014 pilot study on carports attached to manufactured homes, IBHS observed that the carport failure initiated the total loss of the roof structure. A Hurricane Ian (2022) post-event investigation found 42% of homes with identified roof structural damage also had damage to a carport. An IBHS analysis in the same event documented several homes where damage to an attached structure, like a carport or lanai, caused the failure of a metal roof system. These findings suggest that, **like garage doors, carports attached to the structure can be damage amplifiers that result in increased losses** to the main structure when present. These failures can negatively affect the otherwise good performance of other materials and components. In 2025, IBHS will conduct experiments in the test chamber examining the impact and damage to a home from a variety of potential damage amplifiers, including **garage doors, carports, lanais, and pool screen enclosures**.

Field Research: Observing & Characterizing Extreme Severe Convective Storm Straight-Line Winds

Derechos are destructive, long-track, bow-echo squall lines that cause billions of dollars in damage per event. Building-scale interactions of derecho wind fields are not well understood; therefore, fine resolution field observations are needed to capture microscale derecho wind fields and their interactions with both open country and suburban terrain. IBHS has partnered with Texas Tech University to gather observational data of derechos using mobile Doppler radars and rapidly deployable surface observing stations. These experiments **aim to better understand the correlation between roof cover performance and wind speeds away from the hurricane coast**. Also, post-event damage assessments will be performed where possible. Deployments are currently planned for summer 2025 and are expected to continue into 2026.

IBHS RESEARCH PROJECTS 2025

WIND-DRIVEN RAIN RESEARCH

Wind-Driven Rainwater Ingress through Windows & Doors

IBHS research in collaboration with the Cyclone Testing Station in Australia has shown that **windows and doors built according to current design standards remain especially vulnerable to wind-driven rain.** Tropical storms and hurricanes can all force large amounts of water into a building, even with no damage occurring to the windows. When other wind or water damage occurs to a building, water intrusion through windows and doors is often overlooked and not recorded in claims data even though it substantially increases the overall cost of repairs.

Based on observations by IBHS over the past 5-6 years, **water entry through windows and doors should be expected in relatively low wind speeds**. In 2025, IBHS will shed light on these vulnerabilities for Members and other stakeholders by utilizing new wind-driven rain testing capabilities currently under construction at the Research Center. These new capabilities will not only provide critical data researchers need but will also help stakeholders understand where water enters buildings and how easily it does so. IBHS will work to match real-world observations of water entry to expectations from laboratory testing, **ultimately using the research results to develop improved design standards for windows and doors.**

Field Research: Measuring Rainfall Rates & Droplet Sizes

Developing proper wind-driven rain test standards is a substantial challenge as current test standards are not representative of the range of conditions buildings and their components experience in the real world. Post-event investigations and observations from the insurance industry continue to show **wind-driven rain is a damage amplifier**, and the largest foundational gap in wind-driven rain peril research is the lack of observations from hurricanes and severe convective windstorms. Precipitation characteristics vary between these types of storms, and the wind flow alone can change droplet characteristics. These factors affect wetting rates experienced by the built environment. Full-scale testing of this hazard has previously been driven by a single field dataset collected during Hurricane Ike (2008).

To fill this observational gap, IBHS partnered with the University of Florida to construct a new Precipitation Imaging Probe (PIP) observing tower, which had its first full deployment during Hurricane Idalia in 2023. In 2024, IBHS conducted three tower deployments in Hurricanes Debby, Francine, and Helene. In 2025, the tower will be improved to measure rainfall characteristics using three different instruments during hurricane season and modifications will be made to make the tower more deployable in different types of storms, such as synoptic-scale systems (e.g., nor'easters, atmospheric rivers) and severe convective storms. Once obtained, **these measurements will provide further information on the characteristics of the rainfall during a hurricane event** and novel insights into the capabilities and limitations of each of these instruments.

IBHS RESEARCH PROJECTS 2025

HAIL RESEARCH

IBHS RESEARCH CENTER HAIL

Short-Term Aging Performance of IR Products (Emerging Technlogies)

In regions of the United States prone to hail, a solution is needed to **reduce the necessity of early roof replacements caused by hail damage, especially within the first five years of a roof's lifespan**. IBHS's hail impact protocol has identified asphalt shingle products that perform well when impacted with 2-inch ice balls mimicking realistic hail, offering a significant opportunity to **mitigate hail-related losses**. However, it is essential to improve understanding of how the performance of these products evolves over time, particularly during the initial years of a roof's existence. An evaluation of 1-year aged samples in 2023 revealed a notable decline in performance. In 2025, IBHS plans to test both 2-year aged asphalt shingles and 1-year aged samples of a synthetic composite roofing cover, F-wave. **F-wave has demonstrated resilience against 2-inch hail impacts on unaged products**, but there is limited knowledge about its impact performance against hail as it ages.

Wind-Driven Hail Angle of Impact Study & Rapid Deployment of Hail Sensors

Wind-driven hail is a threat to the envelope of residential buildings, yet its frequency and severity remain poorly documented. Several billion-dollar hail events have resulted from wind-driven sub-severe and marginally severe hail, most recently in 2018 in Minneapolis, Minnesota. While damage to roof cover materials (e.g., asphalt shingles) drives a large portion of hail claims, **wind-driven hail events can exacerbate damage and result in damage from hail sizes that otherwise would not cause a loss**, especially to wall cover materials and windows.

When communicating preliminary results of siding impact testing to stakeholders, IBHS received pushback from the Vinyl Siding Institute (VSI), which maintains wind-driven hail is infrequent and therefore eliminates the need for a testing standard. However, in recent years, IBHS has witnessed **significant damage to siding during wind-driven hail events**, including 2024 events in Calgary, Alberta and Rock Hill, SC. IBHS **seeks to understand the frequency of these events** and the risks they pose to cladding materials.

Accurately testing cladding material in the hail lab requires an **understanding of wind-driven hail impact-angle severity**. In-situ wind-driven hail measurements will provide the opportunity to identify a typical range of impact angles during these events and increase understanding of the frequency at which hailstones fall with a significant horizontal velocity component that can damage cladding. A deployable prototype was assembled in 2024, and this prototype will be refined and ready for field operations in 2025.

IBHS RESEARCH PROJECTS 2025

HAIL RESEARCH

High Concentration of Sub-Severe Hail

In 2022, IBHS began investigating the impact of high concentrations of sub-severe hail on asphalt shingle performance, which includes repeated exposure over time. In March of 2024, IBHS presented experimental results from phase one with analytics from ZestyAI at the European Hail Workshop in Karlsruhe, Germany. IBHS showed high concentrations of sub-severe hail damage the roof system **enough to exacerbate aging and lead to asphalt shingles being more susceptible to further damage**. This workshop opened an opportunity for IBHS to publish the work in a special issue in Frontiers "Outcome of the 4th European Hail Workshop 2024." A manuscript will be submitted in early 2025.

Continuing the work in the laboratory, all nine of the phase two panels were pulled off the IBHS aging farm, and impact testing for the second round of sub-severe hail began in late 2024. This will continue into 2025 where **sub-severe impact tests will be completed and followed by the 2-inch impacts of hard and soft ice** according to the IBHS Hail Impact Test Protocol. Future results will be presented to Members, and a written report will be made available. Phase one results have led to a desire for a large-scale experiment that will include wind-driven rain testing to determine if water entry is a threat after an asphalt shingle roof experiences sub-severe hail followed by a large hail event.

Impact-Resistant (IR) Shingles Ratings Refresh & IR Variability Across Batches

In 2024, IBHS successfully expanded the methods to assess hail damage using new commercially available technologies, while ensuring consistency in past and future asphalt shingle performance ratings. In 2025, IBHS will conduct testing for the **2025 IR refresh of the asphalt shingle hail ratings scorecard**. This testing will explore a new method of quantifying the hail damage to asphalt shingles and will utilize a before and after comparison tool to quantify the deformation and granular loss, as well as include a breach measurement. IBHS will also expand the testing to include most of the impact-rated shingles available on the marketplace.

Since the development of the IBHS Hail Impact Test Protocol, **variance in performance scores for the same product has been observed from year to year**. IBHS's 2024 hail team investigated the variance in performance for individual asphalt shingle products resulting from manufacturing processes, storage, and supply chain logistics. The data used a variety of products and shingle batches to explore the range of performance scores due to these variables. In 2025, IBHS will incorporate the findings from the new hail damage method into these results.

IBHS RESEARCH PROJECTS 2025

HAIL RESEARCH

Upper-Bound Sizes of Hail Impacts

The IBHS Hail Impact Test Protocol assesses the performance of impact-resistant (IR) asphalt shingles against 1.5-inch and 2-inch hail, evaluating their resistance to dents, granule loss, and tears. However, **many regions east of the Rocky Mountains in the United States frequently encounter hail larger than 2 inches.** According to a 2017 study by Allen et al., the traditional Tornado Alley region—including states like Oklahoma, Nebraska, Kansas, and the northern half of Texas—experiences a 20-year return period for 4-inch hail. In other severe weather-prone areas like the Midwest, South, and Southeast, the return period for 3-inch hail is also approximately 20 years.

Understanding the upper limits of IR shingles to withstand impacts from large hail is crucial to evaluate performance and costs of products against the return period over which the hazard could cause damage. Laboratory testing in 2022 and 2023 revealed significant damage to asphalt shingles even with just 2.5-inch impacts. Given the severity of those results, field research continues to be conducted to better understand the impact of hailstones larger than 2 inches in real-world conditions and compare the damage modes to those observed in laboratory testing. In 2025, IBHS will expand this work to look at the upper bound of performance for residential metal roofing and synthetic composite shingles.

Damage Detectability & Novel Large Test Chamber Hail System

In recent years, IBHS has worked to develop a new large chamber hail system. This system will be **able to fire 1 to 2-inch hailstones using a magazine system and pressurized air**, similar to the cannon system used in the IBHS hail lab. Once the system is installed, reliability testing will take place before experimental testing begins.

As part of the Roofing Roadmaps, IBHS will investigate cosmetic versus functional damage on different roof cover materials. Multiple test specimens will be impacted with hailstones using the large chamber hail system and made available for Members to visually assess roof cover damage. **The goal is to know the threshold at which hail damage becomes visible from the ground and at what hail size it occurs.** This data will be integrated to further understanding of the hail performance of roof covers.

Field Project: ICECHIP

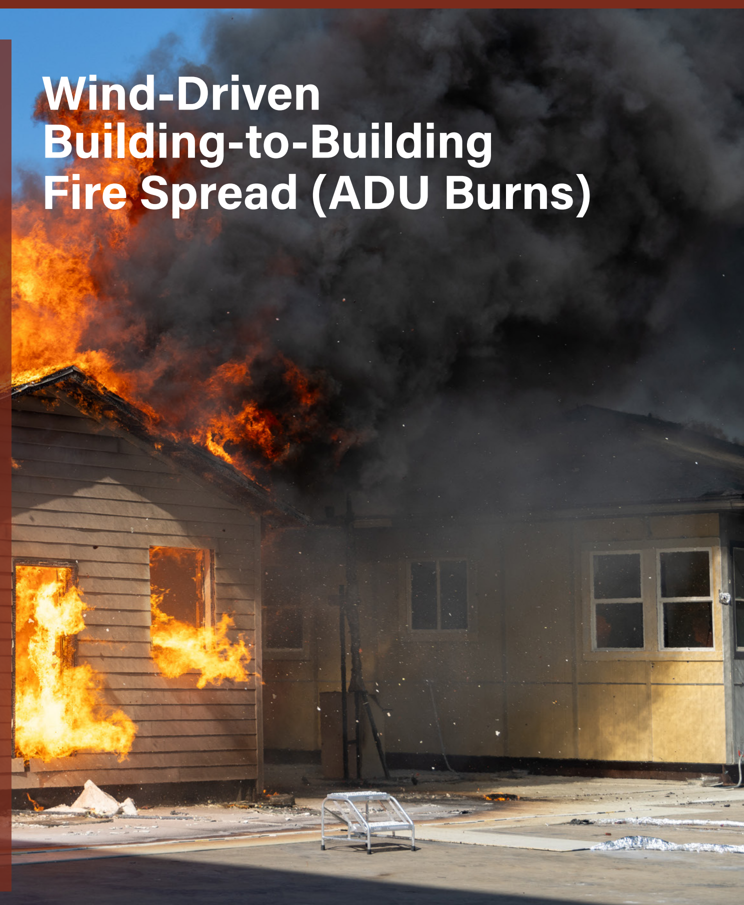
The "In-situ Collaborative Experiment for the Collection of Hail in the Plains" (ICECHIP) project is a multi-organization field research project funded through the National Science Foundation (NSF). **The project is the first multi-institution, federally funded field campaign to study hailstorms since the National Hail Research Experiment in the late 1970s**. The field campaign will take place in 2025 with the possibility of rolling funds over into 2026, depending on field activity. The project will be fully nomadic where teams travel to areas where hail is expected.

As previously planned, the IBHS annual field research program will deploy as part of the ICECHIP project from mid-May through the end of June. The IBHS team will have 24 impact disdrometers, three hail crush test devices, and two 3D-laser scanning systems. IBHS will also provide aerial imaging support with drones to document hail swaths aerially and conduct post-event assessments of building performance.

IBHS RESEARCH PROJECTS 2025

WILDFIRE RESEARCH

Wind-Driven Building-to-Building Fire Spread (ADU Burns)



Building-to-building fire spread is recognized as a major cause of wildfire damage in communities. IBHS collaborated with Underwriters Laboratories' (UL) Fire Safety Research Institute (FSRI) to take the first steps in understanding this problem in 2018 by collecting heat flux data around a burning house in Ohio in the open air at a wind speed of approximately 5 mph. Using this primary dataset, tests were designed to **examine how wind affects fire spread** from a source to a neighboring target building. While the target building remains a full-scale residential building, the fire source was designed to scale up from a shed to an accessory dwelling unit (ADU), and finally a residential building.

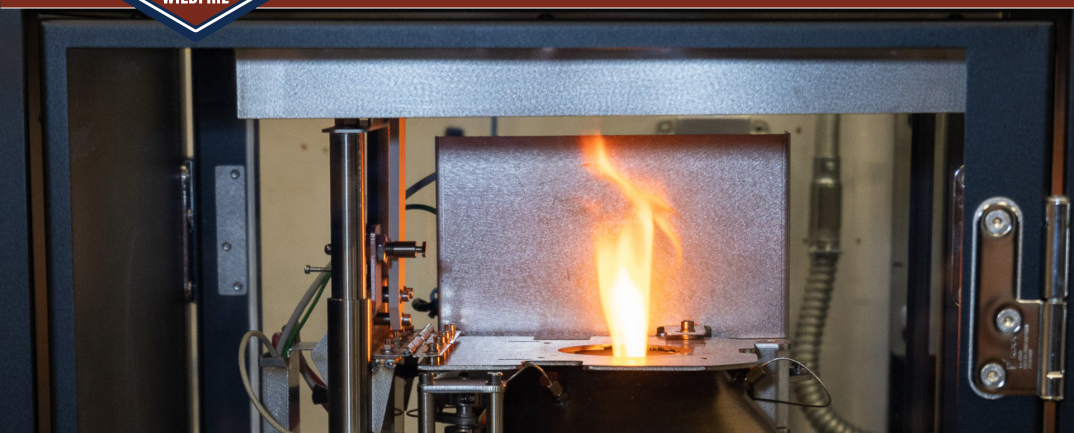
From 2021 to 2024, IBHS collaborated with the National Institute for Standards and Technology (NIST), CAL FIRE, and the US Forest Service for the first phase of testing using sheds as the fire source. In 2024, IBHS began collaborating with CAL FIRE, the University of California Berkeley, FSRI, and the University of Maryland to **investigate the spread of fire from burning, fully furnished ADUs to the main building on a parcel.** Five tests were performed to understand the influence of ADU construction materials (e.g., wood siding, fiber cement siding, and stucco), ignition mechanism (i.e., internal vs. external), and wind speed on the damage mode to the target building. **In 2025, five more experiments will provide further insights into community fire spread.**

Combustion of Ornamental Vegetation

Vegetation adjacent to buildings creates a significant fire hazard. Flames, and the radiant heat coming from **burning ornamental vegetation, can spread vertically through siding, ignite eaves, and break windows.** Yet, burning ornamental vegetation does not always cause severe damage. **The size, location, condition, and species are some of the variables that determine the amount of heat generated when the vegetation burns, which, in turn, determines the impact on surrounding structures.** A series of controlled burns was conducted in 2023 to assess the impact of moisture content, size, and initial mass of various ornamental vegetation species on both the mass loss rate and heat exposure in the vicinity. In 2024, this campaign continued to expand the existing database and run preliminary tests under wind conditions. In 2025, all experimental data, including Lidar scans, will be integrated into **Fire Dynamics Simulator (FDS) simulations to show how fuel coverage density influences exposure in the built environment** along with some experimental validation. Simultaneously, the option of small-scale experiments under the cone calorimeter will be assessed to explore the option of the evaluation of a greater variety of plants within a shorter timeframe.

IBHS RESEARCH PROJECTS 2025

WILDFIRE RESEARCH



BUILDING MATERIALS:

Modeling of Combustion Characteristics

Ignition occurs when energy into a material accumulates and reaches a threshold where ignition is possible. The wind-driven, building-to-building fire spread tests conducted by IBHS in 2023 and 2024 demonstrated the complex interaction of materials heated by large scale fires in a non-steady environment, while the **cone calorimeter provides a steady controlled environment to explore the boundaries of this behavior**. Continued analysis of this data and the introduction of an intermediate scale experiment with IBHS's radiant panel will further help IBHS understand the time-dependent heating and ignition of common building materials in steady and non-steady heating conditions. Ultimately, this research will allow for the development of a probabilistic model for ignition of different building materials.

Relative Performance (Ignition Potential of Products)

In 2025, IBHS will continue to advance **understanding of material performance and probability of ignition for building materials exposed to fire.** The cone calorimeter experiments have enabled progress in understanding energy accumulation, ignition thresholds, and material properties that influence ignition in bench scale tests. The data required to distinguish material performance in wildland fire scenarios for different building materials will continue to be collected in 2025.

Aged Asphalt Shingle Fire Performance

In 2024, IBHS advanced understanding the effects of weathering on asphalt shingle performance through the development of a test method, measuring technique, and sample construction process for asphalt shingle testing in the cone calorimeter. In 2025, this test method will be used on aged samples from the IBHS aging farm to **examine the change in fire performance due to natural weathering.** These findings will later be applied to larger-scale radiant panel testing, enabling IBHS to translate lab-based learnings into more comprehensive real-world assessments.

IBHS RESEARCH PROJECTS 2025

WILDFIRE RESEARCH

Wildland Urban Interface Codes & Standards

IBHS has long played a role in the codes and standards arena, and that involvement and influence continues to grow. In 2024, IBHS submitted a record 16 proposals for the next edition of the International Wildland Urban Interface Code (IWUI). The proposals spanned issues from basic clarification to Zone 0/Home Ignition Zone recommendations, and improved performance criteria for fire spread through wall systems. **In 2025, IBHS will conduct small-scale and intermediate-scale experiments to support additional future proposals specifically related to fire spread through walls.** This area is one of the most significant gaps in the current Wildland Urban Interface codes. These tests on exterior walls were designed to evaluate the performance of WUI Code-specified wall assemblies in the presence of direct flame and heat radiation when defensible space is lacking.

Analytical Modeling for Wildfire Prepared Neighborhood

Using established fire models, empirical correlations from literature, experimental results from IBHS, and observations from post-disaster investigations, **researchers have identified the driving factors of wildfire hazards and developed a framework for wildfire-prepared communities.** This holistic approach accounts for fire exposure and spread potential from all three ignition mechanisms: ember attack, direct flame contact, and radiant heat. The findings guide **strategies to address structure spacing, connective fuels, levels of home hardening, and external fuel management,** such as fuel breaks or fire breaks. Wildfire Prepared Neighborhood will also identify high-risk community features—including structure spacing and connective fuels—to design targeted mitigation measures that reduce the risk of conflagration. In 2025, we will enable Member input as we pilot select neighborhoods.