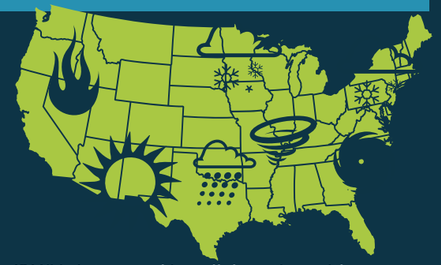
IBHS ROOF FARMS:
EFFECTS OF LONG-TERM WEATHERING

The IBHS Roof Farm project scope was developed to ensure consistent designs and focused variability. Specimens are constructed as a "set." Each set includes new specimens, as well as those that will age for 5, 10, 15, and 20 years. Each individual specimen includes multiple panels to allow for repetition in testing of various wind and hail test standards, and each features north-facing and south-facing panels to examine differences that may occur due to sun exposure.

CLIMATES & ELEMENTS

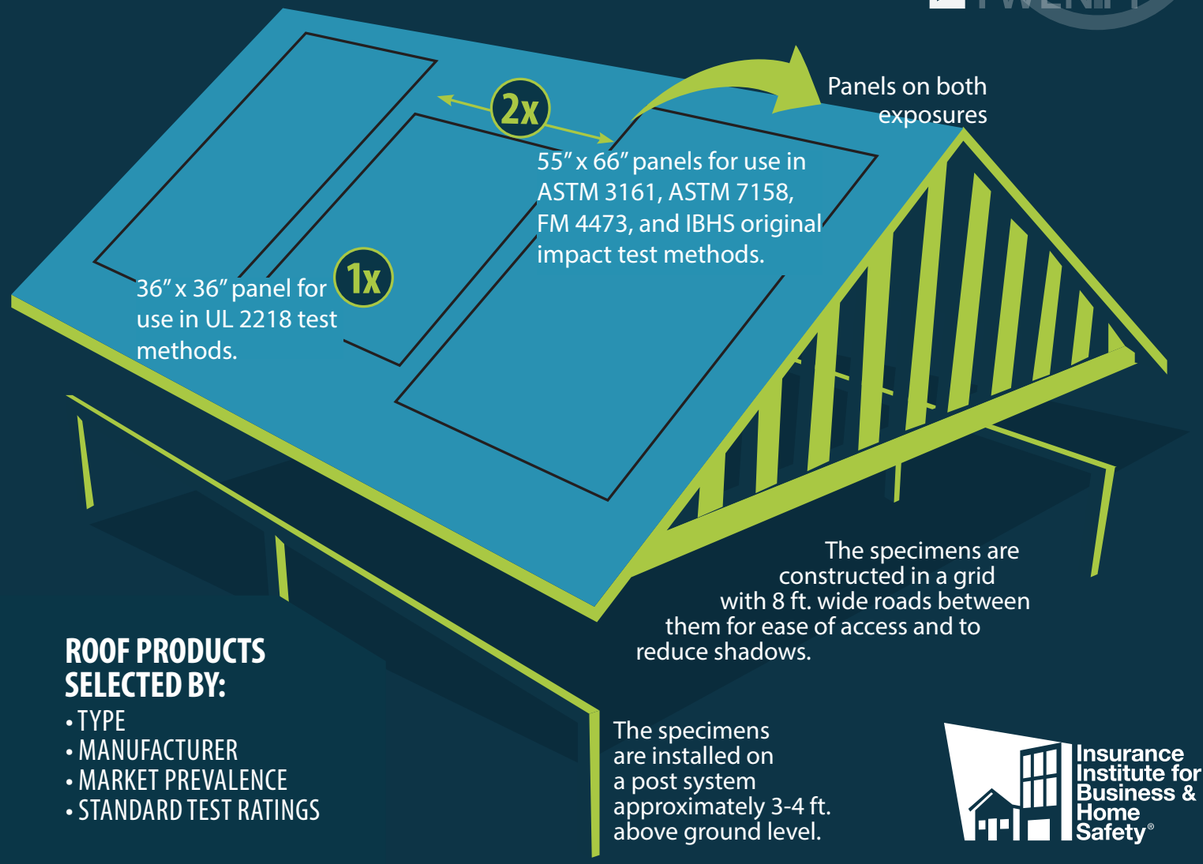


IBHS is interested in collaborating with partners who are willing to construct and install duplicate specimens and similar instrumentation systems at their respective locations.

SCOPE

Each specimen is 15 ft. x 15 ft. with a simple gable roof, 6/12 pitch, and code-required soffit and ridge ventilation. The roof is enclosed on the sides and bottom to create an enclosed ventilated attic. Specimens will be aged for future wind and impact testing. 2,900 sq. ft. (0.07 acres) is required for a "set" of four roof specimens.

YEARS FIVE TEN FIFTEEN TWENTY



ROOF PRODUCTS SELECTED BY:

- TYPE
- MANUFACTURER
- MARKET PREVALENCE
- STANDARD TEST RATINGS

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HOW A ROOF FARM ON YOUR CAMPUS CAN REDUCE LOSSES

Several IBHS closed claims studies have shown that older buildings have higher claim frequencies in a variety of natural disasters. In some cases, this may be due to changes in building codes requiring stronger construction for new buildings. In other instances, it could be due to degradation of building materials or poor maintenance practices for older buildings. Many roofing products are known to degrade over time, with the amount of degradation expected to vary with the local environment. Controlled aging of roofs in various climates coupled with systematic testing for wind and impact resistance will provide needed data to improve vulnerability assessments.

IBHS has initiated a long-term aging program to study performance of aged roofing materials when subjected to high wind or impact tests. Material types, roof pitch, aging lengths, and type of weathering concerns were prioritized by the Research Advisory Council's Shingle Roofing Research Task Force, comprised of council members and Lab Founders within the IBHS Residential Committee.

PRIMARY AREAS OF FOCUS

AGING	MATERIAL	ROOF SLOPE	WEATHERING TYPE
Control (baseline) 5-year 10-year 15-year 20-year	3-tab asphalt Architectural asphalt	6 x 12	Effect of climate Length of aging Directionality of sun exposure

To begin, in 2013 IBHS constructed four replicates of six different asphalt shingles, for a total of 24 roof specimens on the roof farm at the IBHS Research Center. These will be tested in their new states (to provide a baseline), and after aging for 5, 10, 15, and 20 years. Over the next several years, IBHS will expand the roof farm by adding additional roofs with different asphalt shingle materials and other common residential roofing materials. IBHS will use laboratory wind and impact testing results to develop damage curves.

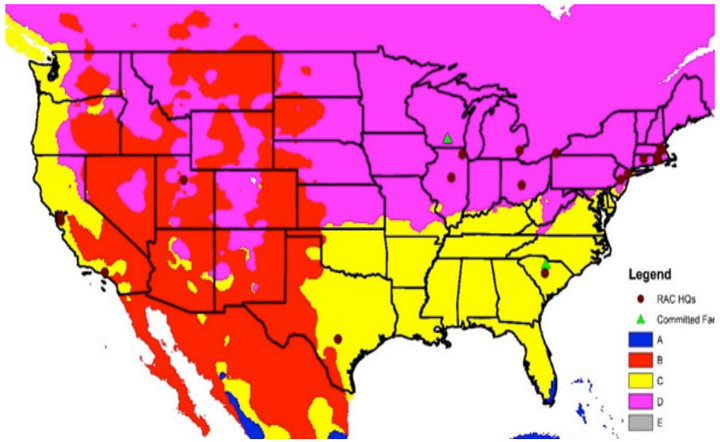

Figure 1: Map of Köppen climate zones in the U.S. Adapted from Peel et al (2007). Ideally, collaborators from various climate zones would install replicates of IBHS aging farm specimens. The locations of the first two farms are also shown.

CLIMATE EFFECTS

Length of time and climate effects may both play a major role in the aging of certain materials. The IBHS Research Center is located in a climate that is hot and humid in the summer, and generally mild in the winter, with occasional snow and ice. IBHS is seeking member companies and/or university collaborators to construct and install duplicate specimens and similar instrumentation systems at their respective locations. Researchers are interested in the effects of other climates, particularly:

- Colder
- Warmer
- Wetter
- Drier
- Prolonged snow and ice
- Thermal shocks caused by thunderstorm rain

Both temperature and average annual precipitation are considered when determining climate. The Köppen Climate Classification System is most commonly referenced within the earth sciences. In this system, there are 20 subclimates and five primary zones in the contiguous U.S., as shown in Figure 1 (adapted from Peel, Finlayson, and McMahon): A (tropical), B (arid), C (temperate), D (cold), and E (polar). At a minimum, IBHS would like to collaborate with partners to construct aging farms with multiple products in each of these five main climate zones.

PROJECT SCOPE AND REQUIREMENTS

The IBHS Roof Farm was developed to ensure consistent designs and focused variability. Each specimen includes multiple panels to allow for repetition in wind and impact testing. Each specimen features north-facing and south-facing panels to examine differences due to incident solar radiation. Specimens are constructed as a "set" with several new and aged panels to allow for comparisons amongst the aging timeframes. Each collaborator can select the number of sets they wish to construct, but full sets must be installed, as partial sets would leave out some age categories. Specific characteristics of the farm include:

1. Nominally 15 ft. by 15 ft., simple gable roofs with a 6/12 pitch, and code-required soffit and ridge ventilation; roofs are enclosed on the sides and bottom to create a ventilated "attic".
2. Specimens are constructed in a grid, with 8 ft. wide roads in between for ease of access and to reduce shadows.
3. Specimens are installed on a post system approximately 4 ft above ground level.
4. A single set of specimens covers approximately 0.07 acres, while six sets cover approximately 0.4 acres.
5. Roof products are selected based on type, manufacturer, market prevalence, and standard test ratings to give variation. Similar colors were selected.
6. Six removable test panels are constructed and installed in the main specimen structure before roof covering is applied.
    a. Three north-facing panels and three south-facing panels
        i. Two each: 55" x 66" panels for use in ASTM 3161, ASTM 7158, FM 4473, and IBHS original impact test methods
        i. One each: 36" x 36" panel for use in UL 2218 test methods
        i. Each specimen set comprises four specimens, one to age for each age category of 5, 10, 15, and 20 years. Six panels of each material are constructed for the new baseline testing.
7. The 5-, 10-, and 15-year specimens for each set feature the same number and location of temperature sensors (Type J or K thermocouples).
8. The 20-year specimen for each set may feature additional sensors for more detailed studies, and a temperature and relative humidity sensor is placed in attic space.

BUDGET ESTIMATES

	Automated Download	Manual Download
Total cost for first set 4 specimens for 1 roofing product	$35,000 to $40,000	$25,000 to $30,000
Total cost for additional sets 4 specimens for 1 roofing product	$27,750 to $30,000	$23,750 to $28,750

SITING RECOMMENDATIONS

- Open, sunny locations strongly preferred.
- Avoid shade from nearby buildings or trees, which will affect sunlight, temperature, melting of snow and ice, evaporation of rain and dew, and activation of sealant strips on asphalt products.
- If an open location is not available, IBHS staff will evaluate the space and determine additional instrumentation that might be required to effectively document roof conditions.

INSTRUMENTATION

In order to fully understand climate effects on roofing products, a number of instruments must be placed on the specimens and monitored for the full project duration. These data are necessary for analysis to understand roof conditions and to allow for comparisons with specimens from other farms. There are two possible tiers of instrumentation—one with automated downloading, and another with manual downloading and saving of data. Within each of these options, there is a range in the number of thermocouples that could be installed. IBHS will be using the first month of data collected at the IBHS farm from very densely instrumented specimens to determine a) the minimum and b) optimal number of thermocouples that are needed for partner farms. Current instrumentation option costs in the budget estimates represent the "best" (cheapest and fewest number of sensors) and "worst" (most expensive and largest number of sensors) case scenario. A portion of the instrumentation will provide infrastructure common to all sets, making additional sets at the same site less expensive than the original set. Customization necessary for integration with existing IT and infrastructure at partner sites may also impact the budget.

SUPPORT

IBHS will supply all necessary construction drawings to ensure the specimens constructed on collaborators' land are consistent with the original specimens constructed at the IBHS Research Center. A list of construction materials will also be supplied. IBHS staff will work with collaborators to choose the appropriate system and will supply a list of all instrumentation components and configuration specifications. IBHS staff will be available to provide support to collaborators during the instrumentation construction and installation processes.

Participants will be asked to maintain the specimens and periodically send data to IBHS. It is possible to configure the automated instrumentation option to send data directly to IBHS with the purchase and installation of additional components and monthly subscription costs. The manual download option requires participants to task personnel with battery maintenance and data collection.

REFERENCES

Peel, M.C., Finlayson, B.L., McMahon, T.A. (2007). Updated world map of the Köppen-Geiger climate classification. Hydrology and Earth Systems Sciences, 11, 1633-1644.