

CARWASH

Chamber for **Analytic Research on Wall Assemblies**
Exposed to **Simulated Weather**



Durability and Wood Protection Research

Forest Products Laboratory
Madison, Wisconsin



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Chamber for Analytic Research on Wall Assemblies Exposed to Simulated Weather

Moisture management is critical for durable, energy-efficient housing. To address the need for research on wind-driven rain intrusion in walls, the Forest Products Laboratory has developed CARWASH, a new, custom-designed moisture testing facility. It facilitates realistic laboratory simulations of wind-driven rain impinging on full-scale wall assemblies.

The method of exposure is unique and represents the physical phenomena typical in rainstorms. Spray nozzles direct water droplets downward into a moving stream of air, which imparts a horizontal velocity component to the droplets prior to their collision with the test wall assembly. In contrast, typical spray tests rely on water pressure fed to a rack of spray nozzles for control of the impact force.

CARWASH enables precisely controlled rain simulations up to 6 inches/hour (150 mm/h) at air speeds up to 25 mph (11 m/s) with variable wind directions. Infrared radiation can be directed at the wall assembly to simulate solar warming. Air temperature and humidity are independently controlled on each side of the test wall assembly, and a static or dynamic air pressure difference across the wall assembly can be established. Individual tests can be programmed with weather data and set to run for weeks or months at a time.



Infrared heat lamps and wind nozzle assembly inside the chamber.

Instrumentation

A computer data acquisition system records readings from sensors in numerous locations:

Conditions within wall assemblies

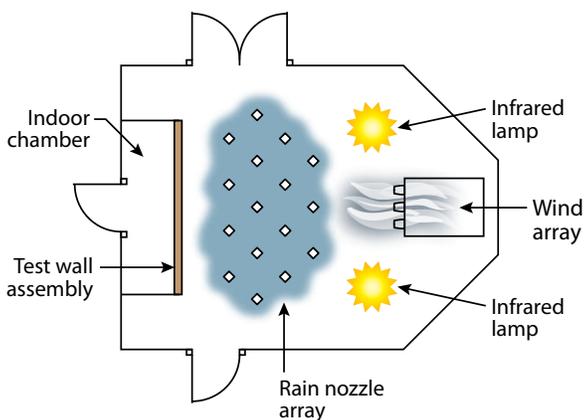
- Moisture content and temperature in wood framing and sheathing
- Relative humidity and temperature at select locations within specimen
- Pressure differentials across specimen components

Exterior conditions

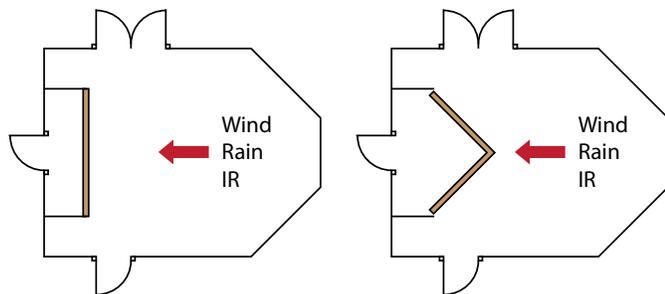
- Dry-bulb temperature
- Dew point temperature
- Wind-driven rain on specimen
- Wind speed and direction
- Net radiation on specimen

Interior conditions

- Dry-bulb temperature
- Relative humidity



Plan view showing main components.



Flat wall assembly.

Corner wall assembly.



Exterior view of CARWASH.

Specifications

Test specimen

Orientation	Flat or corner wall assemblies	
Size	10 ft by 10 ft	(3 m by 3 m)

Outdoor simulation chamber

Dry-bulb temperature	30° to 110°F	(-1° to 43°C)
Dew point temperature	25° to 80°F	(-4° to 27°C)
Rate of change in dry-bulb and dew point	-9° to +9°F/h	(-5° to +5°C/h)
Horizontal rainfall (up to 16 spray nozzles)	0.25 to 6 in./h	(6 to 150 mm/h)
Droplet diameter	0.02 to 0.08 in.	(0.5 to 2 mm diam)
Rain water temperature	50° to 95°F	(10° to 35°C)
Rate of change in rain water temperature	-10° to +10°F/h	(-5.6° to +5.6°C/h)
Wind speed	2 to 25 mph	(1 to 11 m/s)
Wind direction	15° either side of center; randomized or constant rate of oscillation	
Infrared radiation	0 to 100 W/ft ²	(0 to 1,100 W/m ²)

Indoor simulation chamber

Dry-bulb temperature	60° to 80°F	(16° to 27°C)
Relative humidity	30 to 70% RH	

Static pressure differential

Gust simulation	Outdoor chamber pressurized from 0 to +125 Pa for duration up to 5 s	
Steady pressurization	Indoor chamber pressurized to 0, +5, +10, +15, +20, or +25 Pa	



Partial view of rain nozzle array with inset close-up view. Water from rain simulation is collected, filtered, and reused in CARWASH tests.

Applications

- Investigate wind-driven rain intrusion in walls and drying rates after wetting events
- Study the effect of air infiltration and exfiltration on moisture levels in walls
- Provide experimental data for validation of heat, air, and moisture transfer models
- Test innovative wall assemblies
- Test window installation details, flashing details, drainage/drying details, cladding products, and water resistive barrier products



Temperature and humidity sensor.

Forest Products Laboratory

Our mission

We use science and technology to conserve and extend our Nation's forest resources. For almost 100 years, our mission has been to use our Nation's wood resources wisely and efficiently, while at the same time keeping our forests healthy. Many breakthrough technologies that influence the way we live started at the Forest Products Laboratory (FPL).



Our role and experience

Established in 1910 by the U.S. Department of Agriculture Forest Service, the FPL in Madison, Wisconsin, serves the public as the Nation's leading wood research institute. The FPL is recognized both nationally and internationally as an unbiased technical authority on wood science and use. Our research is concentrated in one location to promote an interdisciplinary approach to problem solving. The FPL cooperates with many universities, industries, and federal and state agencies.

Our areas of expertise

Today, more than 184 scientists and support staff conduct research on expanded and diverse aspects of wood use. Research concentrates on pulp and paper products, housing and structural uses of wood, wood preservation, wood and fungi identification, and finishing and restoration of wood products.

In addition to traditional lines of research, FPL is responding to environmental pressures on the forest resource by using cutting-edge techniques to meet important future challenges:

- Utilization of small-diameter timber
- Nanotechnology
- Biorefinery/bioenergy
- Advanced wood structures
- Advanced composites



CARWASH is located in the Centennial Research Facility (CRF), the newest addition to the FPL campus. This 90,000-square-foot combined research facility houses state-of-the-art equipment and laboratories in four major areas of research: Wood Preservation, Durability, Engineering Mechanics, and Composite Sciences.

**USDA Forest Service
Forest Products Laboratory
One Gifford Pinchot Drive
Madison, WI 53726-2398**

608-231-9200
608-231-9592 (fax)
608-231-9544 (TTY)

www.fpl.fs.fed.us



**Forest Products
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