Task 4 Interim Report
Fiscal Year 2011/2012 Scope of Work

1. Scope of Work

Investigate asphalt shingle roof systems performance in hurricane force winds and rain. This is a leveraged research of the grant entitled, "Residential Roof Covering Investigation of the Wind Resistance of Asphalt Shingles (Phase 2)," sponsored by Oak Ridge National Laboratory and continuation of fiscal year 2010-2011 Task 4. The Contractor is authorized to spend up to $100,000 on Task 4. Research is to include:

- *Characterization of wind resistance of asphalt shingles subjected to the combined effects of heat exposure, ultraviolet radiation and rain*
- *Characterization of the fatigue resistance of asphalt shingle seals*
- *Characterization of the effectiveness of resealing shingles and roof repair*
- *Characterization of the effects of fastening schedule and edge detailing*
- *Post-Hurricane forensic surveys of residential building stock*

The contractor shall make recommendations regarding the efficacy of the Florida Building Code, TAS 100-95 for the evaluation of asphalt shingle roof systems based ion this study in a report and provide an interim report to the Commission on progress on the task.

2. Summary of Activities

FBC 2011-2012 funding for the Residential Roof Covering Investigation of the Wind Resistance of Asphalt Shingles supported several critical project activities. These activities are highlighted below and include the construction of test equipment, the development of control systems, and acquisition of materials.

FBC funds supported the construction of the Dynamic Flow Simulator (DFS), which will be used to validate and extend the current wind load model for asphalt shingles originally proposed in 1997 and now used as the basis of the ASTM D7158 asphalt shingle wind resistance test method. This experiment is detailed in Experimental Research Plan (ERP) #7 (attached; see *Task 4 Interim Report - Experimental Research Plan #7*), and is schedule to be conducted in early July 2012. The DFS has seven main components (Figure 1). Air enters the DFS through a 5 ft diameter inlet and passes through an actively controlled opposed-blade damper system, which can oscillate the wind speed at up to a 10 Hz waveform. The air is pulled through an 1800 HP centrifugal blower and the passes through two 90° elbow bends and travels into a settling chamber to remove undesired fine-scale turbulence and to improve flow uniformity across the duct cross-section. The settling chamber consists of a wide-angle diffuser, turbulence screens and a honeycomb, and a duct contraction. Flow uniformity will be controlled by three separate mesh screens of 68% porosity in the diffuser. The duct contraction then causes the wind to accelerate to its target velocity at the entrance to the test section. The cross sectional area at the entrance to test section is 7 ft wide by 1.25 ft tall. The width of the test section does not vary, however the height can be adjusted to regain static pressure lost by friction. In other words, the configuration can be 'tuned' to achieve a zero pressure gradient along the test section. The nominal size of the test specimen is 8 ft long by 6 ft. A pneumatic lift raises the test specimen into place through an opening in the bottom floor of the test section. Air is exhausted to the free atmosphere through a diffuser at the exit, which serves to decelerate the flow.

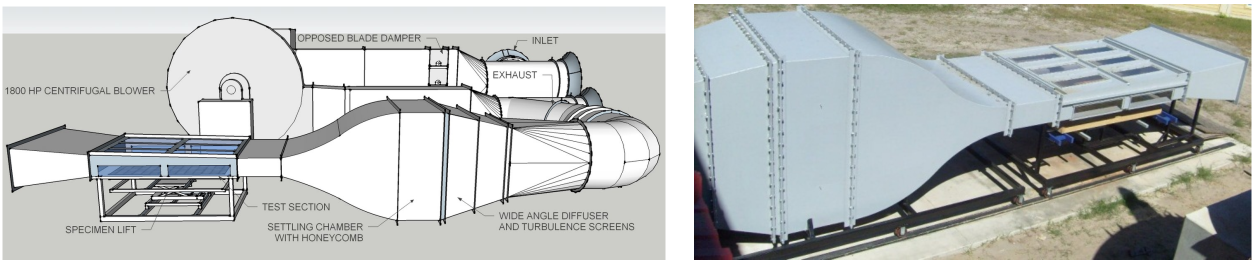

Figure 1. Dynamic Flow Simulator a) componentry and b) as constructed.

UF developed a portable mechanical uplift apparatus in January 2011 in order to perform in-situ ASTM D6381 mechanical uplift tests of asphalt shingles and to characterize the fatigue response of asphalt shingle sealants subjected to time-varying wind loading. Standard universal testing machines are not capable of field deployment due to their large weight and are incapable of replicating turbulent wind loading. Thus, using this portable system it is now possible to deploy this apparatus in the field and test naturally aged asphalt shingles in their in-situ condition on residential homes. The portable apparatus has been successfully used to measure the ASTM D6381 mechanical uplift resistance of approximately 400 naturally aged asphalt shingles on five residential homes investigated by UF. The replication of time-varying wind loading on asphalt shingles is currently under development at UF. Asphalt shingles exhibit non-linear behavior when loaded due to their viscoelastic nature. Thus, a non-linear control algorithm is required to control the uplift apparatus when producing fluctuating loads. Using FBC's financial support, the development of this non-linear algorithm has been contracted to Dr. Warren Dixon of the UF Nonlinear Controls and Robotics group with an anticipated completion by summer 2012. Once developed, an experiment will be conducted to evaluate the response of asphalt shingles subjected to fatigue loading simulating wind pressure fluctuations that occur during hurricane events. This experiment is outlined in *Task 4 Interim Report Appendix - Experimental Research Plan #4*, attached.

The final work during this financial support period is the accelerated aging of asphalt shingles to characterize their long term wind uplift capacity. The first experiment conducted was the wind uplift performance of thermally aged asphalt shingles, outlined in ERP #1, attached. A total of 960 asphalt shingles were subjected to a constant 158 °F heat in a forced air dark oven with their ASTM D6381 mechanical uplift performance and chemical composition evaluated at one of sixteen test period throughout the 32 week aging. This experiment concluded in January 2012 and the results of this work will be submitted to a peer-reviewed technical publication this summer. The second experiment will evaluate the wind uplift performance of asphalt shingles subjected to an accelerated weathering regime of elevated temperature, ultraviolet (UV) light, and water spray. The goal of this test to investigate the combined roles of these three naturally occurring phenomena on the long-term performance of asphalt shingles. This test will be conducted within a 16.5 ft by 4.5 ft by 2 ft high test chamber that is currently under construction and the experiment, outlined in ERP #5 (attached; see *Task 4 Interim Report Appendix - Experimental Research Plan #5*) is scheduled to commence in late April and run for 20 weeks.