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A Response to Katrina: *The making of the largest, most efficient modular building order in US history...*

In August of 2005, Hurricane Katrina spawned the largest natural disaster in our nation's history, decimating the housing stock of the Gulf Coast. In the following two months, Hurricanes Rita and Wilma further extended the housing crisis. Since then, non-profits throughout the country have worked nonstop to develop economical, fast, and basic solutions to the extensive and complex challenge of providing communities with low income and affordable housing.

Unfortunately, the pace of construction cannot keep up with the demand. The construction quality only marginally improves upon pre-Katrina levels, and non-profits are ultimately at odds with themselves as they are distanced from their core-competency, forced to act as contractors and home builders rather than working with families in crisis. This inability to effectively and timely deliver affordable housing has hampered the renewal of the coast from New Orleans, LA to Past Christian, MS to Bayou LaBatre, AL.



In late 2006 FEMA recognized that a new post hurricane housing paradigm needed development. FEMA realized that the complexity and extent of the gulf coast housing problems required solutions beyond their ordinary statutory authority. The U.S. Congress appropriated \$400 million to the U.S. Department of Homeland Security (DHS) to support alternative housing pilot programs that would simultaneously provide both short and intermediate term housing solutions. Working with the state of Mississippi under this program, the Federation of American Scientists has used an innovative approach to develop two modular housing models that are safe, energy efficient, environmentally friendly, and despite the parameters of the program, can be used as long-term permanent housing.

The Alternative Housing Pilot Program and FAS's contribution

The Alternative Housing Pilot Program (AHPP) represents a one-time exception to FEMA's existing authority under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, by providing an opportunity to explore, implement, and evaluate innovative approaches to housing solutions post disaster. At its core, the program is a research project giving FEMA the opportunity to examine new ideas, designs, and processes for housing.

Led by FAS Building Technologies Project Manager Joe Hagerman, Mississippi's proposal for the AHP program represents a new prototype to deliver housing solutions by leveraging the industrialized

housing sector (modular and HUD-code manufacturers) and energy efficient, green technologies. At the core of the proposal are two model units that are built in factories under controlled environments, where assembly and construction is rigorous, optimized, and carefully regulated by full time inspectors. Aply named the Mississippi Park Model and the Mississippi Cottage Model, these homes were heavily influenced by FAS's past successes in building technology research.

The Park Model and Mississippi Cottage were designed to address the shortcomings of the travel trailer and mobile homes used by FEMA following large-scale disasters. Design priorities included energy efficiency, minimal environmental impact, safety, durability, and the ability to provide immediate (short term) yet permanent (intermediate and long term) affordable housing.



The design of each of Mississippi's alternative housing units, like the designs originally offered by the New Urbanist Guild's Katrina Cottage concept, are based upon local architectural style, and are highly adaptable to regional specifics. Mississippi alternative housing units are built with multiple exterior applications, finishes, and colors to give neighborhoods a variety of looks. Each home is designed with adequate floor space, living area, and storage space to accommodate a typical Mississippi coastal family. Further specifications of the home make it comparable to the architecture, structural strength, and typical amenities of local site-built options yet the Mississippi units are stronger, more energy efficient, and more durable.

While both housing units were designed with these same basic ideals, they provide different options for families in need. The Park Model was originally created to address the seasonal needs of National Park Service employees working in remote areas and is regulated under ANSI A119.5. The Mississippi Park Model was designed to remain on a wheeled undercarriage permanently, allowing it to be deployed quickly and removed for redeployment as needed in future disaster events. The Park Model is limited to one-bedroom units with a multifunctional living area that can be used as a second sleeping space. The Park Model also incorporates numerous features to improve safety, livability, and durability over FEMA travel trailer standards. While similar in size to FEMA's travel trailers, the Park Model improves upon FEMA's design in energy efficiency (exceeding energy star standards by upwards of 10%), structural design (meeting International Residential Codes for 150mph winds), use of environmentally safe materials (no-VOC paints/adhesives and formaldehyde free materials)ⁱ, an open floor plan, reduced roof penetrations (to code minimums), the use of durable, rot, mold, and moisture-resistant materials, and a front porch.

Intended for larger families and the disabled, the Mississippi Cottage was designed to meet International Residential Code. The two- and three-bedroom cottages include similar construction techniques and materials as those used in the Park Model, reaching the same high structural, energy, and safety standards. The cottages also offer conventional-sized kitchens, closets and bedrooms, further improving livability. In addition, the footprint of the Cottages was designed to allow for adequate wheelchair access, as required by Universal Federal Accessibility Standards. There is also a door in the utility area that also allows for alternative ramp entry if narrow-lot limitations apply. Unlike the Park Model, the Mississippi Cottage is placed on a wheeled undercarriage so it can be removed if the tenant chose to purchase the unit and make it a permanent residence.

While these significant improvements in energy efficiency and livability are laudable, what makes the Mississippi project so unique is how each model is dual certified as a HUD-Code and International Residential Code-Modular Unit. Dual certification gives the unit the ability for rapid, immediate, and universal deployment to any state without any regulatory hassles. International Residential Code Modular compliance is important for the structures to become part of the long-term housing stock – taking them off their steel frames and undercarriages (and losing their HUD-code designation at this time). Because the units are inspected as International Residential Code Modular for deployment in 150mph wind zones, they are inspected to the highest class or standards. Therefore, when the units are converted onto permanent foundations, the appropriate paperwork and certification of this in-plant inspection can be transferred to the appropriate State or regulatory agency for approval. This facet of the unit design allows the most regulatory flexibility, and maximizes the project's impact.



For example, while FEMA travel trailers serve disaster victims for approximately 2 years, Park Model units are estimated to have a useful life of 15 years, and Mississippi Cottage units are estimated to have a useful life of 30 years. This dual certification – a major goal crafted by FAS's participation in the project – significantly increases the projects ability to have an immediate and long term impact in the rebuilding process, and is an amazing advancement for emergency housing.

An Innovative process for modular housing...

In addition to providing high quality housing relief, the Mississippi AHP project has also been an innovative step for the modular housing industry. Historically, modular housing has been driven solely by a traditional product-to-customer model. The plant produces a product based on their internal research and manufacturing abilities and hires a third-party inspector to inspect the production line. FEMA traditionally has only purchased units off of a manufacturer's lot without clear, concise, and comprehensive specifications. Under the AHP program, the product is very specialized with the look and-feel and the material specifications. The AHP project focused on a research model to design, bid, prototype, and build units in mass as quickly as possible. This new model is extremely important to disaster housing because authorities, such as FEMA, can custom tailor a product to immediately meet their needs while maintaining a high quality in plant and to the end user through rigorous in plant inspections. The AHP project unfolded with five critical stages:

1. **Concept/Design Stage:** scientists, engineers, architects, and emergency responders met to complete a full set of engineering drawings for a specialized disaster housing product, designed with an approved Modular/HUD-code engineering firm operating as the engineer of record (the professional in charge of the project)ⁱⁱ.
2. **Bidding Stage:** The engineer of record advertised and put out for competitive bid the engineering drawings for the specialized disaster housing product;
3. **Prototyping Stage:** The engineer of record along with the scientists, architects, and emergency responders worked with each selected manufacturer to prototype both the quality and construction standards in which the manufacturer will be held. The first unit was retained at the manufacturing facility as the standard of quality. The engineer of record also reviewed and maintained all HUD-code documentation.

4. **Production Stage:** FEMA required a fulltime inspection by the owner's third party/engineer of record to maintain the specifications and integrity of all products shipped (i.e. checking specification, formaldehyde, and energy star compliancy in ALL units); and
5. **Delivery Stage:** Manufacturer will hold the units at their facility until needed by FEMA (to be shipped as just-in-time-delivery).

Effective disaster response does not just bring shelter to people. Rather, it must house people in a livable environment that can renew the local community. The Mississippi project manages to provide energy efficient, safe, livable housing for both immediate and permanent rebuilding through both the design of the units and the process by which the units are manufactured and ultimately procured. Its unique design approach also provides a successful model for the modular industry that can improve adaptability and make further relief efforts more case specific. Inspired by this resounding success, FAS will continue to work with FEMA and other agencies to pursue this and other innovative housing solutions post disaster in a continued effort to affect positive change through science and technology.

ⁱ Note - Formaldehyde exists in nearly all engineered wood products as a resin to bond wood fibers. The Mississippi cottages were designed to minimize the use of products with formaldehyde wherever possible, and materials that could contain formaldehyde was sealed to keep them from off-gassing. All of these materials were inspected for compliance with the HUD-code formaldehyde standard (24 CFR 3280.308) before use.

ⁱⁱ The engineer must be...

- HUD approved Design Inspection Primary Inspection Agency & HUD approved Production Inspection Primary Inspection for easy approval under the HUD-code program
- ICC certified residential inspectors on staff & ICC certified residential plans examiner on staff for compliance and maintenance of compliance to INTERNATIONAL RESIDENTIAL CODE and local codes
- Testing Laboratory accreditation in order to evaluate and review reports for materials, substitutions, and material changes
- Accredited to inspect modular factory built construction & Accredited to inspect manufactured homes in order to act as the third party labeling agency