Draft White Paper

Wind Mitigation Recommendations for FEMA Travel Trailers

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Executive Summary

The widespread destruction of buildings along the Gulf Coast as a result of Hurricane Katrina has spurred a huge demand for temporary housing in Mississippi and Louisiana. As of August 25, 2006, 121, 922 travel trailers and mobile homes served as temporary housing for Hurricane Katrina victims.[1] Of the total, 112,108 or slightly under 92% of these units were travel trailers. An undetermined number of units were park model trailers, with industry estimates of approximately 2,000 units purchased. Although travel trailers and park model trailers are considered mobile travel units, the logistics of rapidly removing most or all of these units from the path of a hurricane or hazard event presents a significant challenge if not a virtually impossible task. The challenge arises from several factors: the total number of travel trailers and park model trailers deployed in the Gulf States; the need to provide long-term utility services to these units; and the necessity of keeping emergency evacuation routes clear. Therefore, it is necessary to address alternative options to provide a secure environment for these units when their occupants are required to evacuate.

This white paper describes current mobile unit layouts; the current wind design standards; the means by which these units may (or may not) be installed to resist flood, wind, and seismic forces; their vulnerability to flood and wind hazards; and their basic compliance with Americans with Disabilities Act (ADA) requirements. Since travel trailers are constructed for temporary and recreational use, there are currently no established wind design standards or design wind speed requirements available for travel trailers. However, there are some standards for park model trailers and there are mitigation techniques and best practices that have been developed for manufactured housing that could be applied to both the design and installation of travel and park model trailers, to make FEMA temporary housing more hazard resistant.

The following long-range (12 to 24 months) recommendations are presented:

- Research and develop design and construction guidance for travel trailers, including design wind speed requirements
- Develop installation guidance for travel and park model trailers for improved resistance to wind and flood hazards
- Research performance of alternatives to travel and park model trailers being used by FEMA in the Alterative Housing Pilot Program (including Katrina Cottages) and note “lessons learned” that might improve the installation process for travel and park model trailers used in temporary housing

Establishing wind design guidance for travel trailers through a consensus process with the industry or completing an examination of alternative housing may not be feasible or possible before the next hurricane season. Therefore, to reduce hazards to occupants of temporary housing, the following short-range (9-18 month) recommendations are provided

- Use park model trailers
- Implement basic, prescriptive travel trailer anchoring and strapping
- Evaluate evacuation plans for impact from the large number of deployed travel and park trailers that have been deployed

[1] Frequently Requested National Statistics Hurricane Katrina – One Year Later Fact Sheet, FEMA Fact Sheet, Last modified 08-Sep-2006 12:09:29 EDT, www.fema.gov/hazard/hurricane/2005katrina/anniversary_factsheet.shtm,

1. Background and Project Team

The Federal Emergency Management Agency (FEMA) routinely dispenses travel trailers (TTs) to disaster victims for temporary housing. The TT industry has no guidelines for the design, construction, or testing of wind-resistant units, nor does it have standard guidelines or methods of attachment or incorporation of anchoring systems for high- wind or flood hazard areas. In response to natural disasters, tens of thousands of units have been dispensed for use as temporary housing. These units have been installed with minimal guidance for wind hazard resistance. Further, many of these units have been placed in floodplains or Special Flood Hazard Areas (SFHAs). TTs placed in an SFHA must meet one of the following three criteria to comply with the National Flood Insurance Program (NFIP): 1) be road ready, 2) be in place less than 180 days, or 3) be elevated and anchored to meet the minimum standards of local ordinances for SFHAs. The number of units deployed in response to the 2004 and 2005 hurricane seasons, and the necessity of providing utility services to these units, means that many of the installed units will not comply with the first two criteria. Further, the possibility of removing these units in response to a new storm is logistically improbable. Therefore, FEMA initiated research into available methods that can be used to improve the hazard resistance of the temporary housing units is recommended. This research should focus on applicable design, construction, or installation guidance that would improve the performance of these units to resist wind and flood loads. Additional research could also include examining alternative approaches to providing a safe, sanitary, and secure environment for the TT occupants

This white paper will identify current TT layouts, hazard vulnerabilities, Americans with Disabilities Act (ADA) requirements, and current wind design standards. The white paper will also provide long- and short-range recommendations for improving design, construction, and testing of TTs for high-wind resistance, and provide recommendations further research to address various installation issues. Evaluating alternative approaches to temporary housing was outside the scope of this white paper.

The members of the project team for this white paper are engineers and researchers with specialized experience in the design and construction of structures used for manufactured housing, building systems design, building damage assessment in a post-hurricane environment, and prediction of damage from hurricanes and other wind events, and include staff from URS Corporation (URS), Dewberry & Davis LLC (Dewberry), FEMA, and other agencies:

- Scott Tezak (URS)—Project Manager and peer reviewer
- John Squerciati (Dewberry)—Project Team Leader and contributing author
- David Burkholder (Dewberry)—Researcher and contributing author, FEMA technical assistance contractor for individual assistance, hazard mitigation and temporary housing
- Shandi Stracke (Dewberry)—Researcher and contributing author, FEMA technical assistance contractor for hazard mitigation and catastrophic planning
- John Ingargiola (FEMA)—FEMA Headquarters, Technical Monitor
- Roger Benson (FEMA)—FEMA Region VII, Project Monitor
- Brian Dekle (North American Catastrophe Services, Inc.)—FEMA TT expert, technical consultant, and contributor

- Dale Peterson (FEMA)—FEMA temporary housing expert and technical consultant
- Don Kidd (FEMA)—FEMA temporary housing expert and technical consultant
- Lawrence Zensinger (Dewberry)—Senior FEMA program expert and technical consultant
- Larry Tanner (Texas Tech University)—National wind engineering expert
- David Low (DK Low & Associates)—Manufactured housing hazard mitigation expert

2. Overview of Current FEMA Temporary Housing

The widespread destruction of buildings from hurricanes, tornadoes, floods, and other natural hazard events results in an immediate need for temporary housing after a disaster. As part of their role in response to natural and man-made disasters, FEMA is continuously working to meet this need as it responds to disasters nationwide. When providing temporary housing, FEMA installs TTs at individual home sites to allow homeowners to stay near their damaged residences; although it is not uncommon to also see TTs provided and installed in group sites. When park model trailers (and manufactured homes) are available for temporary housing uses, FEMA typically installs these in large or group sites as opposed to at individual damaged residences.

During 2004, in response to Hurricanes Charley, Jeanne, Frances, and Ivan in Florida and along the Gulf Coast as a result of Hurricane Katrina in 2005, the need for temporary housing has never been so great. As of August 25, 2006, 121,922 travel trailers and mobile homes served as temporary housing for Hurricane Katrina victims[2] alone. Of this total, 112,108, or slightly fewer than 92% of these units, were travel trailers. An undetermined number of units were park model trailers, with industry estimates of approximately 2,000 units purchased. A brief description and basic requirements of TTs and park model trailers used by FEMA for temporary housing is provided in Sections 2.1 and 2.2. Although these units are considered mobile travel units, the logistics of rapidly removing most or all of these units from the path of another hurricane or hazard event represents a significant challenge, if not a virtual impossibility. The challenge arises from several factors: (1) the total number of travel trailers and park model trailers being used in the Gulf States is very high; (2) each of the units requires long-term utility services which means the TT units should be connected to permanent utility service, and (3) if a large percentage of these units are mobilized at once it could cause problems in keeping emergency evacuation routes clear.

2.1 Travel Trailers

The Recreational Vehicle Industry Association (RVIA) defines a TT as a vehicular unit, mounted on wheels, that is designed to provide temporary living quarters for recreational, camping, or travel use. Further, TTs are considered to be recreational vehicles (RVs). This is important because RVs are exempt from the construction codes for manufactured housing. The definition for recreational vehicles is additionally refined by manufacturers' trade associations. According to the Department of Housing and Urban Development, (HUD) in the Code of Federal Regulations,[3] a recreational vehicle (RV) is a vehicle which is:

1. Built on a single chassis;
2. 400 square feet or less when measured at the largest horizontal projection;
3. Self-propelled or permanently towable by a light duty truck; and
4. Designed primarily as temporary living quarters for recreational, camping, travel, or seasonal use (not designed for use as a permanent dwelling).

[2] Frequently Requested National Statistics Hurricane Katrina – One Year Later Fact Sheet, FEMA Fact Sheet, Last modified 08-Sep-2006 12:09:29 EDT, www.fema.gov/hazard/hurricane/2005katrina/anniversary_factsheet.shtm,

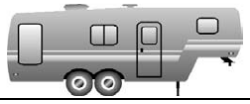
[3] 24 CFR Part 3280, § 3282.8 (g)

Additionally, TTs are of such size or weight as to not require special highway movement permits when towed by a motorized vehicle, and have a gross trailer area less than 320 square feet (29.7 square meters). Table 1 presents the three types of TT units: conventional, fifth-wheel, and TT with expandable ends. Conventional and fifth-wheel TTs, similar to the ones shown in Table 1, have been used by FEMA to provide temporary housing to victims of Hurricane Katrina. There are many instances where these units have been placed in SFHAs. Many fifth wheel units are specialized and fall outside standard dimensions. This paper does not discuss this special class.

TTs fall under several construction codes and federal motor vehicle safety regulations as identified in 29 CFR Part 571; including the National Fire Protection Association (NFPA) 1192 standard on RVs (replacing ANSI 119.2) and NFPA 70 of the National Electrical Code. The NFPA 1192 standard addresses requirements for fuel systems and equipment, life and safety, and plumbing requirements while NFPA 70 addresses electrical systems. There are no industry standards for wind loading nor are there installation requirements for flood-prone areas. As noted in Section 1.1, installation in flood-prone areas is typically regulated by local ordinances guided by NFIP standards. Since TTs are designed for pulling by non-commercial vehicles, the primary considerations for the industry are stability and durability on the highway, ease of pulling and fuel economy.

FEMA specifications for TTs constructed for temporary housing after disasters (see Section 5.3 for additional information) provide for increased electrical requirements (100 amperes) over NFPA requirements for RVs (20 to 50 amperes). FEMA TT specifications also call for removal of holding tanks from units being used as temporary housing. The only exception to these specifications is when off-the-lot units are required to meet dramatic surges in temporary housing needs (such was the case in response to Hurricanes Katrina and Rita in 2005).

Table 1. Types of Travel Trailers

Travel Trailer Type	Profile Sketch	Unit Cost Range (New)	Used by FEMA
Conventional		$8,000 to $65,000	Yes
Fifth Wheel (two levels)		$13,000 to $100,000	Yes
TT with Expandable Ends		$4,000 to $13,000	No

Source: RVIA

2.2 Park Model Trailers

According to the Recreational Park Trailer Industry Association, Inc. (RPTIA) and the A119.5 Recreational Park Trailer Standard, a park model trailer is defined as a trailer-type unit that is primarily designed to provide temporary living quarters for recreational, camping, or seasonal use that meets the following criteria:

- Built on a single chassis, mounted on wheels
- Has a gross trailer area not exceeding 400 square feet (37.15 square meters) in the set-up mode
- Certified by the manufacturer as complying with American National Standards Institute (ANSI) Standard A119.5

Park model trailers are considered a hybrid between TTs and manufactured housing. These units are most often built to customer specifications. Since they are not designed to be easily relocated, materials and construction methods are often more durable than TTs. Many of these units are designed with strapping or load-transfer systems that tie the framing of the unit to the chassis (providing "over the top" securing of the frame to the chassis) similar to manufactured homes.[4] FEMA specifications for park model trailers purchased for installation as temporary housing require compliance with ADA and HUD wind zone III regulations, among others.

The primary issue in using park model trailers is availability of sufficient stock. Since these units are typically built to customer specifications, there is a significantly lower stock on hand at any one time. According to industry experts, annual sales are around 10,000 units per year. Figure 1 shows a photo of a typical park model trailer. FEMA typically uses park model trailers for temporary housing in larger camps or group sites, or when accessibility considerations need to be made. These units are not placed in SFHAs due to NFIP restrictions.

Figure 1. Photo of typical park model trailer (Source: Dutch Park Homes Inc.)

[4] Per personnel communication with Mr. Bill Garpow, President RPTIA by Alan Springett, FEMA HQ.

3. Hazard Vulnerabilities

TTs and park model trailers are vulnerable to the same natural and human-caused hazards as conventional housing. The level and degree of vulnerability is different due to the way these units are designed, constructed, and installed. The level and degree of vulnerability to the different hazards is most similar to flood and wind vulnerabilities that have been documented for manufactured housing (see also FEMA 85); because the TT and park model trailers have design and construction features similar to manufactured housing units. For the purpose of this white paper, we will focus on wind and flood hazard vulnerabilities of TTs and park model trailers in Sections 3.1 and 3.2 that follow.

3.1 Travel Trailers

Flood Hazard Vulnerabilities: TTs may be placed in floodplains or floodprone areas during regular use or use as temporary housing. These units are vulnerable to flood damage because they are typically set up without consideration of the base flood elevation (BFE). In most cases, the units will be installed on foundations that are not designed to resist hydrostatic and hydrodynamic loads created by floodwaters; these foundations also do not typically provide resistance against flood borne debris. Further, the floors and walls of the units have not been designed to resist inundation from flood waters. Because the lowest floor of the units are typically located below the BFE and the units are not on flood-resistant foundations, and are not designed to remain dry with exposed to flood water, a small flood event (less than the regulatory design flood event) may cause significant damage to the units and loss of contents.

As noted in Section 2.1, FEMA TTs may be placed outside or within SFHAs. When the TTs are placed within an SFHA, the units must comply with NFIP regulations (44 CFR Part 60.3 Sections (a) - (f)). These regulations state that a TT located in an SFHA is not required to be anchored and elevated to or above the 100-year or Base Flood Elevation if it is being used for less than 180 consecutive days, and if it is fully licensed and ready for highway use (i.e., on wheels or jacking system, attached to the site only by quick disconnect-type utilities, and has no permanently attached additions). However, if the TT is on a site for more than 180 consecutive days or is not ready for highway use, then it must meet elevation and anchorage requirements to comply with the NFIP; these anchorage requirements are similar to those employed by manufactured homes installed with SFHAs. Elevation and anchorage of the units within an SFHA is not required because it is assumed that when a storm threatens, the TT can be moved out of the SFHA to a safer location. However, the use of FEMA TTs with permanent utility connections (without quick disconnects) for more than 180 days following Hurricane Katrina suggests that these regulations are not being strictly enforced. The use of FEMA TTs for more than 180 days with permanent utility connections (without quick disconnects) and located in SFHAs makes them vulnerable to flooding.

Wind Hazard Vulnerabilities: TTs located in an area subject to major wind events, such as hurricanes and tornadoes, run the risk of being severely damaged or destroyed by the effects of wind and windborne debris. Damaged or destroyed TTs can also contribute to the windborne debris associated with a storm. According to FEMA press release 1603-495 “the high winds generated by a tropical storm or hurricane can cause damage to travel trailers. If a Category 1 hurricane develops, this means winds will reach 74 miles per hour (sustained). At this level extensive damage can be caused.” Although TTs are often anchored or strapped for stability,

specific strapping or anchorage requirements will depend on local officials and installation practices in the jurisdiction where the TT is located (refer to Section 5.1 for additional details). In addition, it is important to note that the strength of ground anchors can be greatly affected by flooding and heavy rains associated with hurricanes and tornadoes, which often increase the saturation of soils used to secure the anchors. Standard practice for FEMA installation is to place TTs on a minimum of six piers, secured by a minimum of four anchors, with at least two anchor straps placed on the rear bumper. This method of strapping is primarily for stability during use. Placing anchor straps on the rear bumper of a TT does not provide maximum resistance to uplift and laterally inducted forces from wind (or other sources). The rear bumper of a TT is designed to resist some horizontal forces, not the vertical and lateral forces that wind-induced loads produce. Rear bumpers of TTs are commonly welded to chassis members that have been welded to the bottom of the TT structural frame and vertical lift from wind overturning moments will produce stresses on the welds that they were not designed to handle.

TTs placed in response to a disaster are used for living space during recovery activities but also provide storage for much of a victim's property recovered from the damaged residence. If another event occurs requiring an evacuation, a large portion of this property will have to be left in the TT and thus subject to possible damage or loss. Since TTs are vulnerable to damage from high winds and floods, these FEMA TTs may become damaged and become wind- or flood-borne debris, thereby increasing collateral damage in an already affected area. For these and other reasons, it is imperative that improved secure installation methodologies be developed. In lieu of this, alternative hazard resistant shelter should be developed.

3.2 Park Model Trailers

Flood Hazard Vulnerabilities: Park model trailers are not installed in SFHAs per appropriate federal, state, and local regulations and therefore are not subject to the same flood hazard risks as TTs located within SFHAs. However, park model trailers may be at risk of damage from flood events that exceed the 100-year storm since their vulnerability to flood damage is primarily mitigated by their location outside the SFHAs. Park model trailers have reduced vulnerability (compared to TTs) only when they are installed using foundations that resist flood-induced forces. As noted in Section 2.2, FEMA uses park model trailers in larger camps and group sites or areas otherwise eligible for placement of manufactured housing that are located outside of SFHAs.

Wind Hazard Vulnerabilities: The park model trailers have similar vulnerabilities to wind-induced damage as TTs. An important difference between the two types of units is that park model trailers are, by specification, designed and constructed to specific, enforceable standards for wind resistance (e.g., HUD, NFPA, and ANSI 119.5). Although these standards do not require resistance for wind-induced forces, they do specify roof live loads and floor live loads (they do not address uplift or laterally-induced loads on walls and roofs from wind). These standards are discussed in Section 5.2. For FEMA installations, the primary consideration is the foundation and anchoring of the units to prevent displacement or overturn. Guidance provided in FEMA 85 for manufactured housing foundations is applicable in some instances to the installation of park model trailers in a hazard-resistant manner; however, these guidelines are not required by any code or standard.

4. ADA Requirements

The ADA requires that access be provided to Federal and private facilities for persons with disabilities. Under the ADA, FEMA facilities such as temporary housing units must use Uniform Federal Accessibility Standards (UFAS), which are design requirements developed under the Architectural Barriers Act (ABA) for facilities designed, built, or altered with Federal funds. UFAS contains requirements for new construction and alterations, including scoping provisions that indicate what must be accessible, and technical provisions that specify how access is achieved. The Access Board develops and maintains the guidelines upon which UFAS is based. In 1984, UFAS became the enforceable standard under the ABA upon its adoption by four standard-setting agencies: the Department of Defense, HUD, the General Services Administration, and the U.S. Postal Service. FEMA temporary housing units comply with ADA provisions through the use of park model trailers that are constructed to meet UFAS requirements and provide wheelchair ramps for access.

5. Current Wind Design Standards

The wind hazard faced by TT and park model trailers was introduced in Section 3; wind is one of the primary natural hazards that can damage these units. However, due to the very different intended uses of each, current wind design standards are not the same for TTs and park model trailers. Sections 5.1 and 5.2 present the current wind design standards for travel and park model trailers, respectively.

5.1 Travel Trailers

Research by project team members and discussions with multiple technical consultants indicate that there are currently no established wind design standards or design wind speed requirements for TTs. Since TTs are constructed for temporary or recreational use, wind design standards have not been established for wind produced by tropical storms, thunderstorms, hurricanes, and tornadoes. The only wind-related design and construction standards for TTs currently available relate to towing requirements for traveling at highway speeds. The towing requirements are typically focused on roadway safety and are concerned primarily with providing stability at the towing couple, not with the design wind speed for the trailer or trailer/vehicle combination.

In general, manufacturers of TTs maintain specific highway speed requirements or recommendations but do not have "in-place" or "installed" design wind requirements; they design the units to be compliant with applicable State-level Department of Transportation (DOT) requirements. This compliance with State-level DOT requirements means that TTs should have adequate wind resistance to be transported at posted highway speeds, usually 55 miles per hour or, in some cases, 65 miles per hour. Based on the wind design section of the American Society of Civil Engineers Standard 7-05, these posted highway speeds only equate to a minimal design wind pressure of 10 pounds per square foot (psf) on the walls of the units (the only comparable TT or park model trailer requirement is provided in ANSI 119.5 Standard for park model trailers for roofs, but has no minimum wall pressure design requirements). However, the ability of TTs to be transported at highway speeds does <u>not</u> mean they are designed to withstand sustained wind speeds of 55 to 65 miles per hour, because:

1. TTs that are being towed at highway speeds are shielded from a majority of the wind pressure by the vehicle towing the trailer and through the aerodynamic design of the trailer itself.
2. The primary wind pressures experienced by the TTs that are being towed act on the smallest cross-section of the unit, which means that much less force is actually transmitted to the unit than if the wind were acting in multiple directions.
3. The connection of the unit to the chassis (or frame) has not been designed to consider loads on the unit, chassis, or connections in between when the chassis is anchored to the ground, but the unit is exposed to moving wind.

TTs are lightweight and designed for mobility, and primarily depend on level placement to ensure stability when set up for use. Stability during use is provided by means of jacks and dry stacked masonry blocks, and may be enhanced using straps; these straps are typically placed over the tops of the units at each end and anchored into the ground. However, many communities do not permit strapping of TTs. This is because the TTs are designed to be temporary, and many

community officials are concerned that residents will develop a "false sense of security" regarding the storm resistance of TTs if they are strapped, since there is no established strapping or hold-down standard for these units.

5.2 Park Model Trailers

Each park model trailer is certified as complying with ANSI A119.5 by the RPTIA member manufacturer who produced the unit. The ANSI standard mandates plumbing, heating, and electrical requirements as well as basic construction standards, but these standards are silent on wind and flood hazards. Two different types of park model trailers are offered. The first type is less than 8.5 feet in width and is designed for travel on highways (where a permit is not required). The second, and more popular, type is wider than 8.5 feet (usually 12 feet in width), and must be transported with special movement permits from State highway departments. The 8.5-foot wide unit is typically expandable when it reaches its destination, utilizing slide-outs or tip-outs. The wider units, being less mobile, are usually sited in a resort or RV park location for an extended term, typically several years.

ANSI A119.5 requires that anchorage recommendations be specified (identified) for all park model trailers; this is typically accomplished by manufacturers indicating the ground anchor(s) and strap(s) to be used and specifying the installation spacing beneath the unit. Unfortunately, this standard only requires the anchor system to be identified; it does not provide prescriptive provisions on the anchors/systems to be used or design criteria (withdrawal or lateral load resistance, embedment depths, etc.) for a system to be designed. Although there are many reasons that prescriptive provisions are not provided, a means to fairly specify site-specific requirements could be prepared as performance-based standards based on the local potential flood or wind loading on the foundation and unit found in ASCE 7-05 and ASCE 24 (the basis for load determination for site-built structures).

Park model trailer manufacturers may voluntarily comply with HUD Manufactured Home Construction and Safety Standards (CFR Title 24, Volume 5, and Part 3280) for wind design, but are not required to comply with those standards. The HUD standards include requirements that the units be designed and constructed to resist wind design pressures based on wind speeds identified from a wind zone map. Park model trailer manufacturers who are members of the RPTIA are required to comply with ANSI A119.5 (and NFPA 1192: Standard on Recreational Vehicles, 2005 Edition). The RPTIA claims that 95% of all park model trailer manufacturers belong to their association.

Based on the HUD Manufactured Home Construction and Safety Standards, the design wind speeds for park model trailers located in HUD basic wind zones will vary. For wind zone I, the design wind speed varies throughout the zone and therefore the HUD standard provides prescriptive design wind pressures in lieu of design wind speeds. In accordance with 24 CFR §3280.305(c), these pressures are $\geq$ 15 psf for horizontal wind loads and $\geq$ 9 psf for net uplift loads. The design wind speeds for park model trailers located in HUD basic wind zones II and III are 100 mph and 110 mph fastest-mile, respectively.

5.3 FEMA Specifications

In addition to the industry standards and requirements for TT and park model trailers, FEMA has two options it may enact when purchasing TTs and park model trailers for installation and use as temporary housing. The first option is that FEMA may specify and purchase units built to a pre-existing specifications document that has been accepted by FEMA (aka "FEMA specifications"). The second option is that FEMA may purchase units "off the lot." During a catastrophic event, such as Hurricane Katrina, a large number of units were purchased using the second option. In smaller events, and as time and supply conditions permit, units are purchased using option one.

At the time of this white paper, the FEMA specifications documents used to procure and install the TTs and park model trailers for use as temporary housing are under review and are likely to change. None of the current specification documents specify or address loads and requirements for flood- and wind-resistant design and installation of TTs. Described below are examples of some of the existing specifications used by FEMA.

Travel Trailers. Travel trailers are required to incorporate a 100 ampere electrical service. This is well above standard electrical service requirements for travel trailers. NFPA standards for travel trailers (NFPA 70-551.42) do not exceed 50 amperes. Each unit must have a telephone and television jack installed. This typically requires common grounding for both to the electrical service panel to meet NEC requirements. The bathroom is required to contain a residential commode and a 36" X 36" transfer shower. The unit cannot contain a separate holding tank. Window mount air conditioning units are not acceptable.

Park Model Trailers. Park model Trailers are required to meet HUD codes for roof load, thermal, be wired to a 125 ampere electrical service, and meet all HUD-issued accessibility UFAS (Appendix A to 24 CFR Part 40). These units are also required to be "Type 3" units, that is, units designed for wind resistance specified as Zone 3 on the HUD manufactured housing wind map. Protection of openings from windborne debris is not required by the HUD code for any wind zone. HUD regulations for Type II and Type III unit wind zone construction do require that the openings around windows and doors be reinforced to accept hurricane shutters. This provides some additional protection should a form of shutter protection be installed, even if that protection is plywood sheathing. Window mount air conditioning units are also not acceptable.

6. Recommendations

Based on the information provided in the previous sections, the following recommendations are provided to improve the flood and wind hazard resistance of TTs and park model trailers being used as temporary housing units by FEMA. Long-range recommendations are presented first, followed by short-range recommendations.

6.1 Long-Range Recommendations and Proposed Research Projects

The following are presented as long-range recommendations. These recommendations involve research to develop wind design and construction standards for TTs and investigation of alternatives to TTs for FEMA temporary housing. These recommendations would be research-based projects that can likely be performed in 12 to 24 months from project initiation, either as research alone or as research related to Hurricane Katrina.

6.1.1 Research Design Wind Speeds for Travel Trailers

To better withstand tropical storm and hurricane force winds, design wind speed guidance needs to be established for TTs. At a minimum, this guidance would be directed towards the use and installation of TTs in hazard-prone areas, but may be offered and developed industry-wide. This guidance should include, but not be limited to, guidance on selecting a design wind speed and should consider the existing design standards for site construction (ASCE 7) and for manufactured housing. Further, wind-related destructive testing should be conducted. This testing would provide a baseline for TT wind damage resistance that could be used to design mitigation methods. It is recommended that FEMA initiate research and testing to determine base vulnerability of TTs to wind damage. In addition, it would be useful to test potential mitigation measures to reduce the overall vulnerability of TTs to wind damage. Such testing would be combined with foundation testing to determine cost effective temporary foundations for placement of TTs in wind or flood hazard areas. This would allow treating the TT and foundation as a system. Potential team members for such wind damage research might include Texas Tech University (TTU), Clemson University, Florida State, and National Oceanic and Atmospheric Administration (NOAA); each of these institutions has conducted significant research in response to major wind events.

6.1.2 Establish Travel Trailer Guidance

Once wind vulnerabilities for TTs are established (Section 6.1.1), design, mitigation, construction, and installation standards, or guidance needs to be developed. This will allow FEMA to procure and install TTs for temporary housing in high-hazard areas with some level of standardized flood and wind resistance incorporated into the TT design. It is difficult to predict if disaster-related temporary housing is likely to be a major continuing segment of the TT industry. As a result, it may be difficult to form the strong partnerships required to set industry-wide new standards for TT construction. Prospective TT buyers have typically three primary considerations in purchasing a TT: cost, size, and power required to move any TT (an add-on cost). Perspective buyers also consider how well the TT meets their recreational wants/needs. The industry will likely have very little incentive to increase cost or weight of their units to meet hazard-resistant requirement. The likely end result will be the need to determine what add-on

mitigation techniques FEMA will be able to employ for installing TTs if these units are maintained as a viable temporary housing option.

In establishing design, construction, and installation guidance or standards for TTs, it will be important to assemble industry experts to determine what the needs are and how to construct TTs to the desired specifications. FEMA has been successful in the past working with industry to prepare design requirements for flood and wind resistant construction. It is recommended that FEMA and its subcontractors host meetings with engineers and building scientists from industry groups and other agencies—such as building code councils, large-scale manufacturers, and academia—to initiate discussions and establish clear and enforceable TT standards.

If the current industry groups prefer that the design and construction standard be developed through a consensus standard process, FEMA could alternatively partner with the industry and support the preparation of a standard. FEMA could share research they have performed, provide seed money to help fund the committee developing a standard, and recommend staff to participate on the committee. A similar approach is presently being used by FEMA in the hurricane and tornado shelter field, where FEMA had produced two documents (FEMA 320 and FEMA 361) to provide design guidance for the design and construction of storm shelters. Additionally, FEMA is working with the International Code Council on a committee working to complete a consensus standard for storm shelters (for tornadoes and hurricanes) that will become part of the building code.

6.1.3 Lessons Learned from Recent Events and Evaluate Alternative Housing Options

FEMA should consider a "lessons learned" study to document effective and successful installation methods that have been used during the temporary housing program over the past several years. This study would identify if different installations have been used, cost implications of the different methods, and an evaluation of the hazard-resistance of the different methods. The goal would be to identify any "new" installation methods that are being employed, to quantify the level of improved hazard resistance these methods provide, and to identify valuable lessons learned from successful and not-so-successful tenant experiences that, from a hazard mitigation standpoint, can be used to improve FEMA's temporary housing program.

Another recommendation is to determine viable alternative temporary housing. A prime consideration for any such housing source should be the scalability of the method(s) chosen. FEMA has begun an initial review of this through the Pilot Alternative Housing Program. It should be noted that a common stumbling block to temporary housing has been the financial, social, and cultural impacts of disaster driven development. It is not easy to find locations in urban areas suitable for temporary housing infill developments. Existing residents find fault with the aesthetics of common temporary housing, sites must be vetted for environmental reasons, infrastructure may be overloaded, communities are uprooted and disrupted and local police and social services are often overwhelmed by the additional load. It is important to note that these issues are important in any study of alternative temporary housing, but this paper also acknowledges that these issues are outside of the expertise of the Mitigation Branch and should be researched and initiated by the appropriate FEMA branch.

As part of either of the above mentioned studies, new housing products on the market should also be considered. One of the new housing products that were a byproduct of the 2005 hurricane season is the Katrina Cottage. In October of 2005, the Governor of Mississippi hosted the

Mississippi Renewal Forum, a one-week session of over 180 architects, planners, and designers tasked to come up with ideas to redevelop 11 small coastal communities that were severely damaged by Hurricane Katrina. Issues identified by the forum led to the development of the Katrina Cottage, which was introduced at the International Builders Show in January 2006 as an alternative to FEMA TTs and park model units. The Katrina Cottage is a small, permanent housing unit designed to be safe, affordable, and assembled quickly. A photo of a basic Katrina Cottage unit is provided in Figure 2, and additional specifications of the basic Katrina Cottage follow:

- Size: 308 square feet (14 feet x 22 feet, plus an 8 foot x 14 foot porch). In addition to the basic unit, larger Katrina Cottages up to 1,200 square feet are available.
- Construction Materials: Wood framing, steel framing, or prefabricated foam-insulated panels with fiber-cement siding and metal roof.
- Construction Schedule: 6 weeks
- Design Wind Speed: Stated as 140 mph (3-second gust)
- Estimated Cost: $35,000 ($55/square foot) plus shipping and fees
- Availability: Materials package for basic Katrina Cottages are available from Lowe's and other building suppliers

Figure 2. Photo of Basic Katrina Cottage (Source: Marianne Cusato)

The Katrina Cottage has generated a great deal of media attention as an attractive and potentially cost-effective alternative to FEMA temporary housing units. However, unlike FEMA TTs and park model trailers, the Katrina Cottage is being promoted as a permanent housing unit that can be installed or built on site and inhabited while a larger house is constructed. The Katrina Cottage is an example of a new housing alternative that is worthy of study as a possible housing option in the FEMA temporary housing program and FEMA should consider conducting a thorough assessment of the Katrina Cottage units to determine if they are a feasible alternative to TTs and park model trailers for post-disaster housing. This study should address many issues relating to both hazard mitigation and public assistance, including but not limited to:

1. FEMA statutory and regulatory restrictions for funding permanent housing (i.e., Katrina Cottages) versus temporary housing (i.e., FEMA TTs and park model trailers).
2. NFIP requirements for placing Katrina Cottages in the SFHA, including construction of elevated foundations and anchorage requirements.
3. Verification of design wind speeds and wind design requirements for Katrina Cottages located in hurricane wind regions, including the impact of elevation on wind design and protection of openings from windborne debris.

6.2 Short-Range Recommendations

The following are presented as short-range recommendations. If establishing wind design standards for TTs or examining alternative housing is not feasible at this time, these recommendations should be considered as an initial effort to improve the hazard-resistance of the FEMA temporary housing. These recommendations could most likely be completed in 9 to 18 months from initiation.

6.2.1 Utilize Park Model Trailers

As noted previously in Sections 3.2 and 5.2, the standards currently established for park model trailers provide some resistance to wind and flood hazards. Therefore, it is recommended that FEMA consider using park model trailers while alternatives are being explored and standards and guidance for hardening TTs are being developed. The primary obstacle to implementing this recommendation is the need to develop cost-effective foundation installation methodologies that comply with current NFIP regulations. An additional obstacle is the fact that some local jurisdictions restrict placement of manufactured housing (including park model trailers) in some areas. FEMA will need to work with zoning officials to overcome this obstacle in a manner that balances local zoning considerations with the need to provide temporary housing after disaster events.

6.2.2 Implement Travel Trailer Anchoring and Strapping

As mentioned previously in Sections 3.1 and 5.1, strapping and anchoring a TT can provide an increased amount of stability to the unit provided the structure of the unit can provide support for the loads transferred by the strapping. In addition, strapping across the top of the unit could potentially provide additional stability and possibly resistance to wind. Therefore, it is recommended that FEMA study strapping and anchoring of TTs while TT wind vulnerabilities are being researched. The primary obstacles to implementing this recommendation are local

regulations that restrict the strapping of TTs in certain communities. To overcome this, FEMA will need to work with the local communities in a manner that balances local concerns about strapping and anchoring with FEMA concerns about increasing protection for the lives and property of disaster victims.

6.2.3 Evaluate Evacuation Plans

It is critical to verify and exercise evacuation plans in areas where TTs are being used. In any area with TT temporary housing, evacuation plans must be reviewed to ensure the vulnerability of temporary housing and the possible increase in the population from the temporary housing is addressed. Current evacuation plans may not take the vulnerability of TTs and population increases into account. It is recommended that FEMA evaluate existing evacuation plans to ensure that they adequately address the needs of TT and park model trailer occupants in the event of a hurricane or tropical storm. In addition, FEMA should require that temporary housing occupants retain a copy of the evacuation plans and understand the procedures, as well as the consequences of refusal to follow local emergency manager directives.

7. References

American Society of Civil Engineers (ASCE) Standard 7-02, Minimum Design Loads for Buildings and Other Structures

Katrina Cottages Web site (http://www.cusatocottages.com/index_content.html)

FEMA Press Release Number 1603-495, dated June 19, 2006, "Prepare Now to Evacuate Your Trailer When Dangerous Weather Approaches" (http://www.fema.gov/news/newsrelease.fema?id=27101)

FEMA Press Release Number 1604-206, dated January 11, 2006, "More Than 31,000 Families Now Housed in FEMA Travel Trailers in Mississippi" (http://www.fema.gov/news/newsrelease.fema?id=22381)

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FEMA Publication 85, Manufactured Home Installation in Flood Hazard Areas

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North American Catastrophic Services, Inc., "Park Trailer Foundation System Specifications"

Recreational Park Trailer Industry Association Web site (http://www.rptia.org/)

Recreational Vehicle Industry Association (RVIA) Web site (http://www.rvia.org/AM/Template.cfm?Section=HomeRVIA)

Uniform Federal Accessibility Standards (UFAS) Web site (http://www.access-board.gov/ufas/ufas-html/ufas.htm)