Universal Floorplan Design for FEMA Disaster-Relief Housing

SME Panel Meeting #3

FEMA Headquarters
Washington, D.C.

Tuesday, February 9, 2016
9:00 am – 12:00 pm Eastern

SME Panel

Charley Boyer, COO/VP-Manufacturing Division, Oak Creek Homes
Charles Fanaro, President, Hi-Tech Housing
Larry Stephan, CFO, Hi-Tech Housing
Mark Mazz, Principal, Mark J. Mazz, AIA, LLC
Chet Murphree, General Manager, Deer Valley Homes
Delmo Payne, President, River Birch Homes
Tom Rehrig, Special Projects Manager, Clayton Homes
Manuel Santana, Director of Engineering, Cavco Industries
Michael Wade, Director of Manufacturing Operations, Cavalier Homes, *Panel Chair*
Harold Weaver, President, Lexington Homes
Bert Kessler, Vice President, Engineering, Palm Harbor Homes
Mike Terrian, General Manager, Platinum Homes

Staff

Matthew Rabkin, MHU PMO Manager, FEMA
Emanuel Levy, Executive Director, Systems Building Research Alliance, *Panel Facilitator*
Pournamasi Rath, Senior Associate, Systems Building Research Alliance
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Guests

Mark Ezzo, VP-Engineering, Clayton Homes
Jayar Daily, Vice Chairman, American Homestar
Jim Bauer, Director of Quality Assurance & Code Conformance, Clayton Homes
Lois Starkey, VP-Regulatory Affairs, Manufactured Housing Institute
Robert Hawkins, Contracting Officer's Representative, FEMA
Ed Taylor, Project Manager-DHS, FEMA

Meeting Minutes

The meeting commenced with introductory remarks by SME Panel Chair, Mike Wade. Self-introductions were made around the table and by those joining remotely. The meeting agenda was discussed.

I. Objectives[1]

The panel clarified and expanded on some of the project goals as follows:

1. **Incorporate a broad base of MHU supply—**Although one of the goals is to provide a detailed and consistent set of plans and specifications for the MHUs, the panel sees value in maintaining flexibility in certain design and construction aspects. These aspects would correlate with shorter lead times, less retooling, and fewer changes to individual manufacturers' standard protocols. This is expected to result in shorter lead times when MHUs are ordered. A few examples were cited: provide flexibility in unit and hallway

[1] See project website for an updated list of project objectives

widths (a single solution for UFAS and non-UFAS occupancy), allow for multiple product brands wherever possible, and consider alternative furniture holdings.

[Action: SBRA will conduct a survey that characterizes manufacturers' standard widths and dimensions. The narrowest widths typically inventoried and manufactured will be noted. Include in the upcoming survey questions regarding the furniture procurement process and vendors. Attempt to identify common vendors and agree on typical furniture items/sizes.]

2. **Reduce the weight of the Express units**—The weight of current Express units poses challenges in terms of shipping over the road. To reduce tottering during transport, the current 17,000-lb. weight should be reduced with a target weight of 12,000 lbs.

[Action: Evaluate the components that contribute to the Express unit's weight and recommend changes that reduce overall weight. For example, consider using 2x6 floors instead of 2x8, using SPF lumber rather than SYP for flooring and walls, and substituting a lighter material for the OSB on the sidewalls.]

II. Design Review—Express unit[2]

The panel weighed in with changes to the Express Unit design including the following:

1. **Minimizing design variation**—While this was not the original approach to the Express unit, FEMA representatives and the panel agree that minimizing differences between UFAS and non-UFAS units should be a goal for all unit types.

[**Action**: The express units will be significantly redesigned to reflect universal UFAS-compatibility and flexibility in terms of individual manufacturers' standard dimensions.]

2. **Overcoming spatial challenges inherent to Express units—**Many parts involved in making Express units are not "off-the-shelf" and thus induce delays, including axels, cross-members, roof trusses, and floor joists. Rabkin suggested that FEMA might cover the purchase and warehousing costs to store the specialty parts involved in making Express units in order to resolve this issue.

[**Action**: Include in the upcoming survey questions to identify items with long lead-times and research costs to FEMA of pre-stocking these items.]

3. **TPS placement**—Finding room for the tank-and-pump system in Express units is still a design challenge, perhaps to be addressed separately from that of the 1-, 2-, and 3-bedroom units.

[**Action**: Articulate the pros and cons of adding the TPS to different locations—e.g. the end of the unit or the bottom of the unit—while avoiding additional setup time and labor and extraneous bulk and weight. Present findings to SME for guidance.]

4. **Room allocation—**Comments regarding living area included: HUD Code requires at least a partial room divider between the front and back door, and the required living area of 150sf. must be maintained with the clarification that the kitchen may be counted as part of the living area if the space is contiguous.

[**Action**: Place a partial wall near the end of the kitchen which will be incorporated in the redesign of the Express unit.]

5. **Standardization and availability of furnishings—**The current Express units only allow for small furniture sizes that are not readily available. Additionally, the panel observed that mini-stacked washer/dryer units as specified in the current designs may not be available in sufficient quantity for immediate needs.

[2] See Attachment A for Express Non-UFAS layout

It should be noted that specifications not required by code or statute may be open for reinterpretation in designs—for example, Rugged-Base Specifications calling for a full-length couch may be changed to two armchairs instead.

[**Action**: Procure standard dimensions from major furniture vendors. If considering built-in furniture, investigate the increased labor time and cost difference associated with this solution. Specify standard (stackable) washer/dryers for Express units. Survey manufacturers to determine general availability of UFAS-compatible appliances.]

6. **Windows—s**imilar to furniture, window dimensions should be standard and window area minimized.

[**Action**: Optimize window placement while maintaining at least 8% window-to-floor area, as per HUD Code 24 CRF 3280.103 (a).]

7. **Meeting anticipated standards—**Exterior walls of the Express unit may be built with 2x4 framing with approved code exceptions, but it would be preferable to meet the anticipated DOE thermal standard. Thermal calculations can be done during the design phase in order to determine whether 2x4 walls would meet the proposed code.

III. Design Review—1-, 2-, and 3-bedroom units[3]

1. **Dimensions**—Actual unit widths for a 14-foot nominal width vary from plant to plant. Parts associated with an actual 14-foot-wide unit are not "off-the-shelf" for most facilities. Interior framing dimensions may need to be increased (2" x 4") to accommodate services.

[**Action**: Design for the narrowest width and allow for flexibility in width to be accomplished by varying circulation space. If a wall houses a panel box, plumbing, the TPS riser, or a mini-split, it should have a nominal width of 4".]

2. **Modularity—**The panel agreed that it is favorable to create floorplans that are altered as little as possible between the 1-bedroom, 2-bedroom, and 3-bedroom layouts.

[**Action**: Maintain modular relationships between the 1-, 2-, and 3-bedroom units while decreasing the width of the MHU designs.]

3. **Accessible design variation**—The goal of having a single design for each of four unit types was reiterated. The design aims at providing a universally accessible unit for Express, 1-bedroom, 2-bedroom, and 3-bedroom layouts. The contractor will pursue this goal while characterizing the sacrifices that follow from this decision (longer delivery times, inefficient use of space for non-UFAS users, higher cost, etc.). It was noted that although pocket doors can allow for more compact design, they are not manufacturing-friendly.

[**Action**: Remove distinction between UFAS and "Enhanced" units by standardizing all features. Evaluate the drawbacks of this uniformity—e.g. limited usable space between counters and cabinets, repeated bath/shower controls, and limited inventory of appliances. Insurmountable differences will be addressed as they arise.]

4. **Defining "CONUS" beyond thermal packaging**—The panel concluded that an MHU is not fully "CONUS" unless it meets all state requirements (or is granted exceptions), fits within existing lots in group sites, and can operate within the electrical power constraints available at any site. Specific challenges might include:

    - California's Wildland Urban Interface requirements dictate the use of heavier materials and other methods of fire prevention.

[3] See Attachments B, C, and D for 1-, 2-, and 3-bedroom layouts

- At some sites, only 60 amps is available. The fire suppression tank-and-pump system alone requires 30 amps.

[**Action**: Investigate California Wildland Urban Interface (CWUI) requirements to determine which deserve the most attention (http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_codes). Determine whether separate material specifications should be maintained for CWUI units. MHI volunteered to survey communities to determine typically-available amperage and the viability of using an "A/B" current switch, where one setting (e.g. "A") sets the unit to run on the minimum amperage offered, whereas the other setting (e.g. "B") sets the unit to the full amperage.]

5. **Placement of controls**—Placement of certain fixture and appliance controls is not optimal as designed.

[**Action**: Bath/Shower controls should be placed on the interior wall instead of the exterior wall for ease of manufacturing and thermal considerations. Repeat or place the controls on the side of the bath/shower in order to ensure accessibility for those with physical limitations.]

6. **Windows**—The current design shows roughly 9% window-to-floor-area. This figure can be reduced to 8% of the total gross floor area, as required by HUD Code (24 CRF 3280.103 (a)). Room-by-room window area requirements must also be met, except for in the kitchen, mechanical room, and bathrooms.

[**Action**: Investigate other window configurations to optimize the designs and place windows where necessary while maintaining the required window-to-floor-area ratio.]

7. **Exterior doors**—FEMA has experienced water intrusion with exterior doors, some of which is due to wheelchair-accessible thresholds, but much of which is due to lack of attention to airtightness around door frames in general.

[**Action**: Visit Selma or Cumberland storage sites to diagnose the problem. Based on these observations and related analysis, specify doors of higher quality and proper flashing. Design an integral bulk-water diversion system. This system may include a dormer or (detachable) overhang over the door and/or an L-diverter.]

IV. Fire Suppression—Tank-and-Pump System (TPS)

1. **Manufacturability—**While more inclined to include the TPS unit within the MHU as opposed to an external, free-standing design, panel members expressed concern about the lead time required to order the TPS parts and added weight of the TPS if installed before transport. Manufacturers also prefer to use pre-assembled "unitized" systems with controls in place to avoid requiring additional labor during assembly.

[**Action**: Design a compartment within the MHU that leaves room for market-available, unitized TPS systems. Suggest inventorying necessary products to avoid the concern of delaying the manufacturing process. Compare these "internal" design solutions to the "external," "doghouse" solution.]

2. **TPS placement—**Most panel members prefer a single unitized system inside the MHU's thermal envelope for the 1-, 2-, and 3-bedroom units given the challenges associated with shipping and siting an external TPS system. However, in the case of an external system, the panel favored the idea of 'divisible loads' by having the TPS placed on another conveyance as a means of limiting the overall unit load. However, on-site installation would necessitate a method of placing the TPS inside the MHU post-production, as well as create challenges with designing universal connections between TPS and distribution systems. If the TPS is incorporated in the MHU, it is less likely to

be retrieved and recommissioned for use by FEMA, but its associated reduction in cost compared to an external unit may compensate for its inability to be recovered by FEMA.

[**Action**: Consider design options with versatile factory installation. If exterior access is preferred due to monthly servicing and spatial limitations, specify access doors that prevent moisture intrusion.]

V. Fire Suppression—Distribution System

1. **Location—**Below-ceiling distribution systems have the advantages of ready access to the component parts, fewer envelope penetrations, and a location within completely conditioned space. The main disadvantage is aesthetics which can be partially addressed by use of pre-manufactured soffits. Side-wall soffits are easier to install and are visually more appealing than the ceiling option. Manufacturers would not build their own soffits because of the time required, and pre-manufactured soffits offer easy accessibility.

[**Action**: Design the distribution system to be entirely below the ceiling and designed for a sidewall sprinkler and soffit layout.]

VI. Mechanical Systems

1. **Water heating—**FEMA MHUs are all-electric and an electric instantaneous water heater creates a high instantaneous electric demand exceeding electrical system capacity. Further, to avoid differences among the unit types, water-heater type should be kept consistent between the 1-, 2-, and 3-bedroom units. Additionally, tankless water heaters currently require an AC letter for HUD code compliance.

[**Action**: Research current draw of properly-sized tankless water heaters to assess their appropriateness for applications in the Express and possibly other units. Verify that tankless units will provide adequate water temperature for all CONUS locations.]

2. **Space conditioning—**The panel agreed that mini-splits are favorable in terms of efficiency, have the advantage of not requiring floor space, and eliminate the need for ducts. Routing the condensate at the indoor units will have to be managed carefully.

[**Action**: Research variable-speed/capacity mini-splits (VRS or VCHPs) for providing comfort and efficiency in a wide range of climates (CONUS concept). Units with variable speed or capacity could have the flexibility to accommodate all necessary climate zones year-round while maintaining optimal COP. In placing the indoor unit(s), care should be taken to avoid clashing with the sprinkler system, since both systems reside on the upper wall.]

3. **Air distribution—**Mini-splits may require low-sone transfer fans for air distribution with minimal noise disturbance. A ceiling-mounted mini-split head system (ceiling cassettes) was suggested to achieve better air distribution.

[**Action**: Continue exploring air-distribution systems incorporating the findings from the recent AHA test house.]

4. **Ventilation–**Ventilation has yet to be discussed in detail. Balanced ventilation is required by HUD Code 24 CRF 3280. 50-90 cfm must be provided. Ducted systems offer an advantage of routing outside air to the house through the space-conditioning system.

[**Action**: Design a ventilation system in parallel with space conditioning. If using a ductless mini-split, introduce outside air via a separate means.]

VII. Primary Action Items

1. **SBRA -** Disseminate a follow-up survey and continue with floor plans and mechanical-system designs.
2. **MHI/Lois Starkey -** Check on status of AC letter approval for tankless water heaters and mini-splits. Also look into space considerations, typical electric provisions, and other constraints of MH communities to inform length and width limitations of the MHUs.

VIII. Wrap Up

Next meeting date: March 31 (tentative), in conjunction with a visit to the Selma, AL storage facility.

Location: 661 Selfield Rd, Selma, AL