

# TECHNOLOGIES

## Part 2: Emerging Trends in Foundation Design

*This article is part of an ongoing series devoted to looking at how industry is moving beyond anchored foundations and traditional chassis designs. In Part 1, Steve Hullibarger explored trends in foundation design and changes in site preparation practices. In Part 2, writer Jennifer Goode discussed with several manufacturers, integrated floor systems—one of the most promising innovations in the design and fabrication of the home itself.*

The manufactured housing industry is growing away from the traditional "single-wide" model.

More manufactured homes are used to revitalize inner-city neighborhoods. More homes are placed in developer land-lease subdivisions.

And the homes more closely resemble site-built construction—sometimes all the way down to the basements.

"The common theme of the industry is creating value for customers," says Jeff Wick, president and CEO of **Wick Building Systems** in Mazomanie, Wisconsin. "It's becoming ever more housing and ever less mobile. This move to houses on basements is highly representative of that trend."

As more customers

want houses they can put on permanent foundations, some industry members have adapted existing designs or developed new ones that allow for affordable, HUD-code homes placed over basements.

"Our retailers were requesting a faster, simpler method of installing homes on basements

without using the old standard frame with the cross-beams embedded in the basement walls," said Jack Ireton-Hewitt, division general manager of **Titan Homes** in Sangerfield, New York.

Transporting a typical home to a site and cutting

**Trends continued on page 4**

### Inside

Part 2: Emerging Trends in Foundation Design 1

From the Chair: Innovation Through Collaborative Research 2

Project Update: Air Duct Systems 8

Project Update: Moisture Field Testing 10

Publications 11



The underside of a floor prior to installation of the bottom board and frame at Wick Building Systems.

## Innovation Through Collaborative Research

MANUFACTURED HOUSING

### TECHNOLOGIES

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I have been asked on many occasions why an organization like the Manufactured Housing Research Alliance (MHRA) is important to our industry. I think there are several very good reasons why the organization is not only important to our industry, but critical to our long-term growth and credibility in the housing market.

Few manufacturers are in a position to spend large amounts of capital or human resources in the conduct of research and development. While this statement was true in the past it is even truer in the current environment of shrinking budgets and smaller labor pools. Because of limited funds and because we are in an industry where innovation does not always immediately result in improved sales and revenue, it is very difficult for any of us to justify the large expenditures of time and money needed to develop significant leaps in the manufacturing processes or materials used to manufacture our homes. Housing, however, will continue to be an increasingly competitive market where affordability and value will drive sales.

Even when we are able to devote limited funds to research and development, our efforts are by necessity concentrated on trying to improve or refine current construction processes and materials. Not many of us are in a position to devote the time, effort or money necessary to develop truly innovative processes.

Many wrongly believe that the primary responsibility for research and development should fall to our component and material suppliers. They claim that market driven forces will provide the impetus for change and that our suppliers must be the ones to step forward to meet these demands. Many larger suppliers, especially those with a large presence in the site-built industry, do have impressive research and development facilities and have developed and commercialized many innovative products. However, they will be first to tell us that they cannot shoulder this responsibility alone. They must have an active partner in the development of products and more importantly in the generation of ideas for future products. There is even a more fundamental reason: suppliers develop patentable products and technologies that serve their business goals first, and the manufacturer's interest second. This leaves a huge void—who is developing technologies that may be in the manufacturer's interest, but not their suppliers?

Joint research that benefits the whole industry is by far the best opportunity we have to develop ideas that will fuel our continued growth in the housing market. Using a broadly-funded and widely-endorsed organization like MHRA as the vehicle to perform this cooperative research not only makes sense, it is the only realistic way to

take advantage of our collective experience, expertise and limited resources.

All of us have great people with years of experience, but none of us can individually dedicate these people exclusively to research and development. There are always far too many pressing day-to-day issues that occupy the time and energy of our people. We must have an organization like the MHRA to draw us together—to keep the focus on research, allowing our talented people to guide and manage these efforts.

While it is important to have an organization like the MHRA to facilitate the conduct of research, it is equally important that the MHRA provide a forum for the exchange of ideas. Every industry grows faster if the major players work together. One of the strengths of the MHRA is that its membership and governing board consists of representatives from every facet of the industry. Suppliers, power suppliers, retailers, community owners and developers, lenders, regulating agencies, consumer advocates, research laboratories, manufacturers and others are all MHRA members. This broad coalition does far more in moving the entire industry forward than any single company or group of companies can achieve acting on their own.

The fact that ideas for research can be presented by any member of this diverse group helps create an environment where innovative approaches to meeting the needs of our customers can be given quick and fair consideration. Through the MHRA we can assess and develop new ideas and concepts, concepts that otherwise might never be pursued by individual companies, and demonstrate their technical practicality and market viability. In this cooperative research environment, we are collectively able to consider the merits of a new concept without bias and with insight into the obstacles to development and opportunities for commercialization.

The existence of the MHRA clearly demonstrates to those that watch our industry (consumers, suppliers, stock analysts, government agencies, etc.) that we are interested in the development of innovative approaches in meeting the needs of our customers. It demonstrates that we will not let ourselves become stagnant and complacent because we do not have the resources or collective will to develop and implement new ideas. The MHRA has, in the short time it has existed, significantly contributed to the advance of manufactured housing research. With our continued support it will provide an excellent means of promoting and conducting collective research that will move our industry forward. 🏠



A handwritten signature in blue ink that reads "Rick Boyd". The signature is fluid and cursive.

Rick Boyd, Chair

out the steel floor beams to allow it to sit level on a foundation damages the structural integrity of the home. This also violates the HUD code, that requires structural components of the chassis that

(Manufactured Housing and Standards Division) made it clear that you can remove only wheels, axles and axle-hangers, and the towing hitch," Wick said. "Their argument was that under the language of the enabling legislation, if you did remove the structural chassis members you wouldn't have a permanent chassis, and it wouldn't qualify as a HUD-code home."

*"The common theme of the industry is creating value for customers. It's becoming ever more housing and ever less mobile."*

Jeff Wick,  
Wick Building Systems

**Design alternatives**

Manufacturers have responded to that challenge, predominantly by offering two types of integrated floor systems—

are required for transportation to remain with the home on site.

"The HUD people

With integrated floor construction, utility runs are mainly limited to the space between the floor joists.



Integrated floor system with a column set of every twelve feet.

steel-reinforced perimeters or steel floor beams incorporated into the floor trusses.

"Here in the Northeast where basements are popular, (steel reinforced perimeter floors) have turned out to be a nice option for our customers," says Ireton-Hewitt.

"The steel frame runs

around the perimeter of the home, while the floor joists support the weight in the center."

Wick uses the Lindsay Unified Floor System, developed by Fred Lindsay. According to [www.housingzone.com](http://www.housingzone.com), Lindsay's system works as follows:

"On the road, the wheel/axle assemblies support a pair of longitudinal steel beams under the house, like a standard HUD-code chassis, with the long sides of the box cantilevered. Where this differs from convention is that the girders are contained within the height of the floor structure, passing through and unitary with transverse trusses, which support a perimeter girder. This girder is either a built-up steel channel or wood 2 x 12's (less expensive than steel, but deeper). Floor loads are picked up by the trusses, which may be



all wood or wood with steel cords. The steel cords allow for a 1" reduced floor depth."

**Schult Homes**, based in Middlebury, Indiana uses a similar system that employs a series of transverse, steel chassis beams within the height of the perimeter girders. This cuts down on the thickness of the floor and transfers the load to the axle springs and drawbar in transport. The beams allow homes to ride lower to the ground, reducing shipping height.

Both the perimeter and integrated floor systems allow for more useable space in basements under manufactured homes, several manufacturers noted.

"The heating ducts, plumbing lines, gas lines, and other services are included in that space underneath," Ireton-Hewitt said. "It makes a simple, neat package for setting it on a basement."

"It's popular, traditionally in the Midwest, if it's going to be on a land-home situation," said Dave Shaffer, director of engineering for **Patriot Homes** in Elkhart, Indiana.

Shaffer developed the floor system that Patriot uses—a strengthened, slightly altered chassis that is fastened directly to the foundation.

"If you're putting in a

crawl space with footings below the frost line, you're already half the way to a basement. A basement doubles the living space at only a slightly higher cost," Shaffer said.

These foundation alternatives are likely to remain a niche market for most companies. Manufacturers that concentrate on the basic homes for entry-level buyers are not likely to embrace designs for homes that could be placed on basements any time soon. "In a park setting, extra habitable space may not be an option," Shaffer said.

Also, in states such as Kentucky and Tennessee, rocky soil hampers the excavation of basements. In most of Florida and Louisiana, the water table

is too high to allow deep digging and the traditional foundation system in these areas is crawl space.

*"A basement doubles the living space at only a slightly higher cost."*

Dave Shaffer,  
Patriot Homes

#### Impact in manufacturing

Using an integrated floor system, or a perimeter system, requires changes in the manufacturing process, which has contributed to some manufacturers' reluctance to embrace the technology.

Wick said his plants easily accommodate the

differences now, but that they didn't at first.

"It did take some learning," he said.

Shaffer said he developed a system that integrated well with Patriot's current manufacturing methods. "We'd tried some other types of systems, but our previous attempts were not production

friendly," he noted. "Our current system was something we could do without interruption on our production lines. That was our main goal."

"Most plants are set up to do something traditional, and change is hard

**Trends continued on page 6**

Treated stem wall of a Lindsay Unified Floor design.



to accommodate. It is a pain in the beginning to retrofit a little," said Elliot

New Era uses several variations on Lindsay's integrated chassis design.

*"Ten years from now I think you'll see eighty percent of manufacturers will have not only found that they can build (integrated floor systems) and there is a market, but that they can also move their lines as fast as before."*

Elliot Fabri,  
New Era Building Systems

Fabri, president of **New Era Building Systems** in Strattanville, Pennsylvania.

floor systems) and there is a market, but that they can also move their lines

"But ten years from now I think you'll see eighty percent of manufacturers will have not only found that they can build (inte-

as fast as before," added Fabri.

He likened it to the advent of drywall in the manufactured housing industry.

"Back 10 years ago hardly any manufacturers did finish drywall. Then the demand became greater and greater," Fabri said. "Drywall slows the line down. But over time, it went from a couple of manufacturers doing a little, to a little more, then a little more," Fabri said.

"Today it's more the rule than the exception that almost every company at least drywalls several of the rooms. And that is what I see happening with integrated chassis systems."

### Market trends favor integrated floors

Fabri offered some other advantages with the use of the integrated-chassis homes: "It allows you to stack the units, two stories. That would not be possible without the integrated chassis."

### The Manufactured Housing Institute's

Urban Demonstration project in Wilkinsburg, Pennsylvania, and Louisville, Kentucky, among other urban areas, has demonstrated the use of integrated floor technology. The system offers more affordable homes with more square footage on smaller lots.

The New Colony

This Lindsay Unified Floor System uses a new "three-minute hitch" that saves on crane time.



Village project, which was developed in Jessup, Maryland, where land prices are at a premium, used such two-story homes manufactured by Schult.

"It gives you the flexibility—there's multiple ways to support it," Fabri said. "You could use the system in developments such as along the coast, where you could put the house on pilings."

Most companies that use the innovative flooring systems say that they don't install them on anywhere near a majority of their orders.

Ireton-Hewitt says about 7% of Titan's customers purchase the strengthened-perimeter option. "The floor system was introduced three years ago. And each year



The removable wheel assemblies support a pair of longitudinal steel beams under the house and are used to transport the home to the site.

the number of homes sold with this option has grown," he added.

Fabri and Shaffer said anywhere from 10% to 15% of their customers place their homes on

basements.

"Today (integrated floors) are a significant part of our business," Wick said. "There are two benefits—it allows us to continue to offer HUD-code housing with a lower cost, and to offer the benefits of HUD-code housing to a consumer who wants to place the house on a basement," Wick said.

#### **The cost premium**

The cost of fabricating the stronger perimeters or the integrated chassis is passed on to the

consumer. As a niche market, integrated floors come with a considerable cost premium.

Wick says the difference in his homes is now on the order of a few hundred dollars. "When we started there was more of a difference."

Fabri cites similar figures for New Era homes. Titan homes of typical size cost approximately \$1,500 more with the strengthened perimeters, Ireton-Hewitt said. Shaffer noted that Patriot Homes offers the option at about \$1.60 more per square foot.

"There's really not a big price difference, it's just a different way to build," Fabri said. 🏠

This house built by New Era Building Systems utilizes the Lindsay Unified Floor System.



# Air Duct Systems

Virtually all of the nation's manufactured homes use forced air systems for heating and cooling distribution. Recent studies suggest that the duct systems in these homes have relatively high leakage rates, contributing to high energy costs, moisture problems, and homeowner discomfort. A recent study revealed that the system losses in an average duct system accounts for 40% of an average home's total heating energy use and 15% of total cooling energy use. These large numbers represent a readily available opportunity for making cost-effective improvements in the design and installation of duct systems. Prior efforts have demonstrated that duct system heating losses can be cut to a reasonable limit of 5% and cooling to 3%. Such



reductions, applied to the average manufactured home, would reduce energy bills by an astounding 23%.

In a continuing endeavor to assist manufacturers in improving the performance of their duct systems, MHRA is sending building scientists to plants across the nation, evaluating their current practices, identifying methods to improve performance and then retesting the systems. The effort is made possible partly with funding from the US Departments of Energy and HUD. Plants interested in the duct system evaluation, should contact MHRA.

As a first step, MHRA Project Coordinator, Francis Conlin visited two plants evaluating their duct system practices. Here is a sampling of his initial findings.

## Plant #1

This plant uses a metal trunk duct, predominantly with perimeter supplies and metal tape used for sealing. The trunk is mostly constructed offline except for the in-line registers.

	Problem	Solution
	<ul style="list-style-type: none"> <li>• Metal crossover duct splitter box is not mechanically secured to furnace connector boot in three of four homes—critical connection held together with one layer of foil tape. This can lead to disconnections of the crossover duct splitter boxes.</li> </ul>	<ul style="list-style-type: none"> <li>• The crossover duct splitter box and furnace connector boot were pre-assembled off-line and should have been secured with 4 screws. Install screws offline when duct pieces are first assembled.</li> </ul>
	<ul style="list-style-type: none"> <li>• Connector for in-line supply register riser has very narrow profile (less than 3”), making installation through subfloor time-consuming.</li> </ul>	<ul style="list-style-type: none"> <li>• Install wider (4”) in-line boots or convert the in-line boots to short perimeter type flex duct connections.</li> </ul>
	<ul style="list-style-type: none"> <li>• Furnace connection box and rectangular-to-round flex duct takeoffs have numerous tabs that are bent over to mechanically fasten these joints. This is time-consuming and involves many sharp edges and unnecessary leakage sites.</li> </ul>	<ul style="list-style-type: none"> <li>• Redesign box without tabs or use a single bendable flange instead of hard-to-seal tabs; redesign takeoffs with wider or single flaps.</li> </ul>
	<ul style="list-style-type: none"> <li>• Uninsulated supply ducts in the floor system are prone to moisture condensation during air conditioning.</li> </ul>	<ul style="list-style-type: none"> <li>• Insulate all supply trunk ducts; add a 4 to 6” insulation wrap on the exterior of the crossover collars and in-line boots.</li> </ul>



## Plant #2

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This plant uses a metal trunk duct with predominantly in-line supplies, occasional metal branch sections and metal tape for sealing.

### Problem

### Solution



- Metal “cross-over collar” is being deformed into an oval shape to accommodate a larger 12” cross-over duct. This can cause significant leakage after setup.
- Section box and holes in trunk for supply risers are cut “blindly” with a hand held knife—hole will not be as accurate. Hand held knives are more prone to slipping and cutting through side wall of trunk.
- Metal tape is used to seal the furnace-to-trunk connector. This area has the highest pressure and temperature, and is the most important connection in the entire system. Metal tape performs poorly when used under the heating coil to seal this connection.

- Use a tensioning tool to connect duct to collar (collar will go back to round shape); use at least 4 screws through tabs into trunk and tape along collar seam to secure connection.
- Use zip spiral saw or similar tool, combined with a template to cut a more accurate hole that is easier to seal.
- Use superior mastic fiberglass tape instead of metal tape to seal connection.



- Both folded and rolled up end cap systems are used; folded end cap is screwed shut, but large gaps are simply taped over. After a period of time, vibrations and poor adhesion can cause this seal to fail, resulting in significant leaks.
- Outdoor air ventilation duct is connected directly to top of furnace—ventilation air will not receive direct dehumidification. This has been associated with poor humidity control in humid climates.

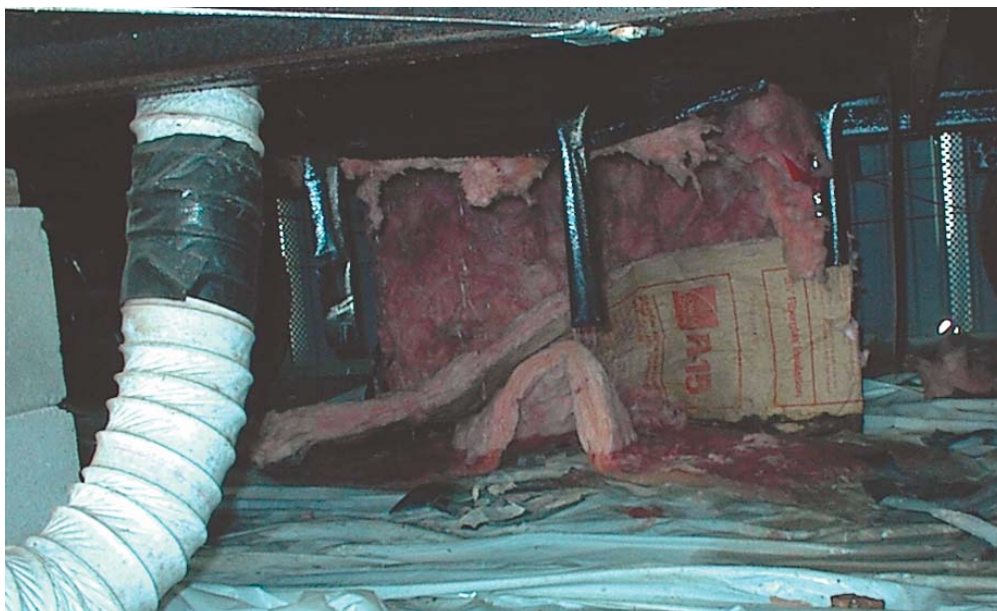
- If adequately folded and fastened with screws, the “rolled up” end closure system may be a more durable, leak-proof seal; use seam sealing pliers to squeeze connection tight.
  - Ventilation air intake should be redirected to pass over the cooling and dehumidification coils when air conditioner is installed in the field.
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## Moisture Field Testing

The MHRA recently published ***Moisture Problems in Manufactured Homes: Understanding Their Causes and Finding Solutions***, documenting moisture problems and suggesting preventative measures for avoiding moisture-related damage in new homes. Seeking to further reduce future moisture problems in manufactured homes situated in hot, humid climates, the MHRA is implementing a project to:

- pinpoint the major contributing factors to moisture-related damage in manufactured homes.

Crawl spaces of homes visited in Port Fourchon, LA varied from well-sealed bottom boards and a nearly complete ground cover to those with a minimal ground cover, high water marks and significant belly breaching.



- identify and/or develop construction, installation and operational alternatives that effectively control or reduce the flow of moisture.
- distribute the findings to the manufactured housing industry and consumers.

Some of the factors that can contribute to moisture problems include: ventilation of attic cavities, damage to the bottom board, duct leakage, and over sizing of air conditioning equipment. This study will establish the relative contribution these and other factors make to moisture accumulation.

Through field analysis and surveys, laboratory testing, and simulation analysis, this effort will develop the tools, building methods and information needed to eliminate most of the underlying causes of moisture problems in manufactured homes located in hot, humid climates.

Project tasks include: characterizing existing moisture problems in hot and humid climates; investigating control homes that show no evidence of moisture problems; and establishing relationships between



Clogged air handler filters were observed during field visits in Port Fourchon, LA.

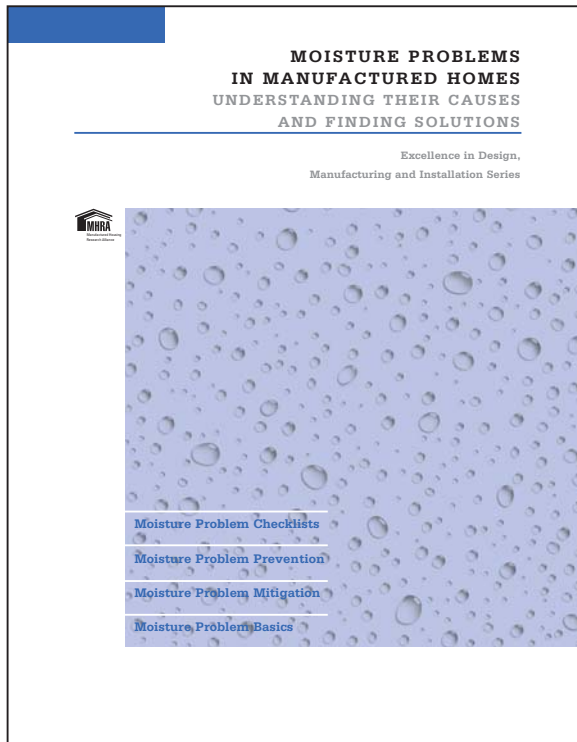
building characteristics and moisture problems. Subsequent phases will consist of laboratory testing, as needed to identify contributing factors to moisture damage and building new homes using alternative construction designs and manufacturing methods intended to eliminate moisture problems.

Preliminary data was collected during a field visit to manufactured homes in Port Fourchon, Louisiana earlier in January. The crawl spaces in some of these homes had signs of moisture damage, particularly

Moisture continued on page 12

## Design and construction guidelines

- Manufactured Housing Duct Systems: Guide to Best Practices**, The first volume in the MHRA *Excellence in Design, Manufacturing and Installation Series*. This guide provides information for improving air distribution system performance in manufactured housing and includes design, installation, and material selection recommendations. This guide will help manufacturers evaluate their current design and construction practices and identify options for increasing system efficiency. (Members, \$35 plus shipping; non-members, \$50 plus shipping.)
- Moisture Problems in Manufactured Homes: Understanding Their Causes and Finding Solutions**, This guide is the MHRA's most recent addition to its *Excellence in Design, Manufacturing and Installation Series*. This 60-page guide is designed to assist manufacturers, retailers, setup crews, and homeowners in recognizing and solving moisture problems in manufactured homes. This user-friendly guide provides information on moisture sources, movement, and accumulation, and offers strategies for avoiding moisture problems and curing problems when they do arise. (Members, \$35 plus shipping; non-members, \$50 plus shipping.)



- Cooling Equipment Sizing Charts**, Guidelines for properly sizing heat pumps and air conditioners. Manufactured Housing Research Alliance, New York. States currently available: AL, AR, AZ, CO, FL, GA, IL, IN, KY, LA, MS, NC, NM, NY, OH, OK, OR, PA, SC, TN, TX, and VA. (For prices, request sizing chart order form.)

- Ground Anchor Selection and Installation Chart**, This chart, presented on a durable, laminated card, indicates the maximum spacing of anchors for various combinations of wind zones and home designs. Installers simply need to know the HUD wind zone and a few features of the home, including section width, main I-beam spacing, and pier height. The chart suggests the proper anchor spacing, depending on the desired anchor length, and whether the home is a single or double section. Instructions on using the chart are found on the back of the card along with a helpful example. Also included are guidelines for the installation process. Available in English and Spanish. (Members, \$2.50 per chart plus shipping; non-members, \$4.00 per chart plus shipping. Volume discounts apply.)
- Structural Insulated Panels in a Manufactured Home Roof System: Engineering Guidelines**, Manufactured Housing Research Alliance, New York, 2000. (Members, \$95 plus shipping; non-members, \$250 plus shipping.)

## Technical reports

The technical reports provide a summary of the engineering analysis supporting MHRA projects.

- ***Guidelines for Anchor System Design: Technical Support Document***, Manufactured Housing Research Alliance, New York, 2000. (Members, \$15 plus shipping; non-members, \$95 plus shipping.)
- ***Manufactured Housing Fuel Switching: Field Test Study***, Manufactured Housing Research Alliance, New York, 1999. (Members, \$15 plus shipping; non-members, \$95 plus shipping.)

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those with a minimal ground cover, high water marks over the ground cover and significant belly breaching. Although homeowners changed their own filters monthly, all of the air handler filters were completely clogged. Three-row air conditioning coils were used where four-row coils and other designs can provide better dehumidification. Rust in light fixtures indicated past condensation of humid air from the attic onto the light fixtures.

MHRA building scientists will be visiting homes in states with hot and humid climates including the coastal areas of Texas, Alabama, Mississippi, and Florida that have experienced moisture-related problems. Companies wishing to participate in this study should contact MHRA. 🏠

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**TECHNOLOGIES** welcomes letters from our readers. If you have comments or questions, or if there are topics you'd like to see covered in future issues, please contact MHRA at 220 West 93rd Street, New York, NY 10025; or info@research-alliance.org.

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