The Newsletter of the Manufactured Housing Research Alliance Volume 2 Issue 3

MANUFACTURED HOUSING TECHNOLOGIES

Solving Moisture Problems in Manufactured Homes

Moisture, as liquid and vapor, is an integral part of daily life. We breathe it, drink it, bathe in it, and use it for growing foods. We don't often think of it as being the cause of a potentially serious problem in housing.

Most building materials can tolerate occasional wetting—as long as they also have sufficient exposure to air, which allows moisture to dry out. At times, however, circumstances prevent drying and cause moisture to build up to amounts that can damage a home. When damage does occur, it can be difficult to diagnose and expensive to repair. Extreme moisture problems can degrade the building material's strength and insulation capacity; support mold and rust growth; and increase the weight of building materials beyond the capacity of supporting structures.

Moisture-related problems are relatively rare, but are occurring with greater frequency in new homes, particularly in the hot, humid areas of the nation. Moisture problems, however, can occur in all climates and regions.

The best approach for avoiding moisture-related problems is to take preventative steps that keep excessive moisture buildup from occurring. These steps can be found in ***Moisture Problems in Manufactured Homes: Understanding Their Causes and Finding Solutions,*** the Manufactured Housing Research Alliance's most recent addition to its *Excellence in Design, Manufacturing, and Installation Series*. This user-friendly guide is designed to assist manufacturers, retailers, setup crews, and homeowners in recognizing and solving moisture problems in manufactured homes.

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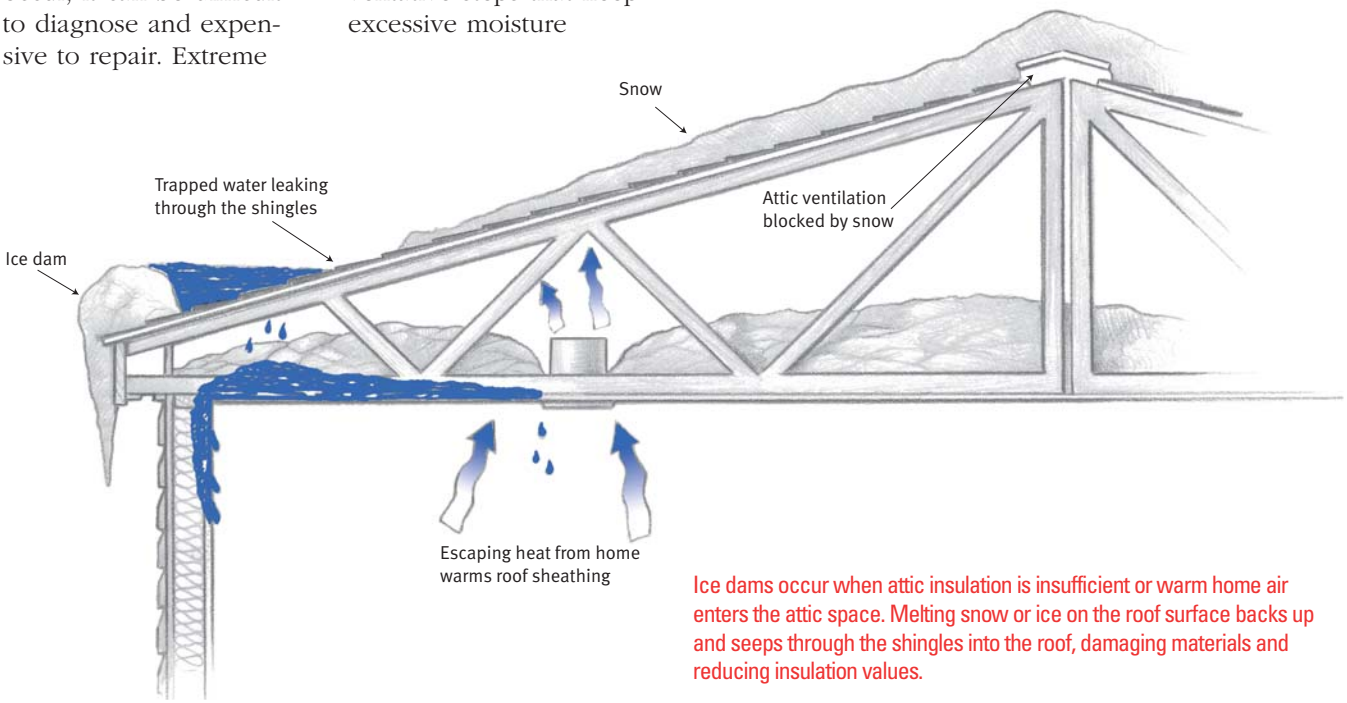

Ice dams occur when attic insulation is insufficient or warm home air enters the attic space. Melting snow or ice on the roof surface backs up and seeps through the shingles into the roof, damaging materials and reducing insulation values.

The Seeds of Change

MANUFACTURED HOUSING
TECHNOLOGIES
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Admittedly 2000 was not a banner year for the manufactured housing industry. Some of the best-laid plans (business plans, that is) are in shambles causing one industry analyst to refer to the entire industry as "tornado alley." In many regards, it's a year we would sooner forget and the industry takes little solace in the fact that only e-commerce had a more precipitous, more financially devastating and more visible fall from grace. But amongst the rubble, the seeds were being planted for changes intended to set the industry on a firmer footing to compete and prosper in the business of providing homes.

Nowhere is this more apparent than in our growing commitment to research. Several MHRA projects neared completion this year or were initiated that promise to help strengthen our position in the housing market.

Manufacturers and suppliers have for years questioned whether the entire structural framework of the home, not just the underfloor I-beams, should be made of steel instead of wood. Compared to wood, steel is more dimensionally stable, fire resistant and less subject to pricing fluctuation. Yet, no manufacturer had yet produced a cost competitive steel design. This was a task ripe for MHRA investigation.

By the fall of 2000, the MHRA project Committee Chaired by my colleague at Oakwood Homes, Mark Ezzo, produced a steel design bearing a DAPIA stamp: the first hurdle had been overcome. As expected, the design came in above comparable wood framing cost (by about 15% in material costs alone). This was a promising result; after all, the industry has spent over 25 years value engineering wood framing and had yet to sink it's teeth into this first-cut steel design. By mid-Winter, the project team had begun to wring out the design excesses and were cautiously predicting a dramatic cost reduction. Subcomponents of the new design will be laboratory tested to demonstrate their equivalence or superiority to the wood framed system they are designed to replace. Third party testing will be followed by the fabrication of a full scale light gage steel manufactured home for transportation testing and manufacturing analysis. This will be an exciting project to follow in the pages of **TECHNOLOGIES** over the next 12 months.

This year also saw the completion of the eagerly awaited moisture guide profiled in this issue. The guide sums up known sources of moisture-related problems in homes and actions that can be taken to minimize such problems. In the course of the work, the extent of moisture problems plaguing homes placed in areas that have prolonged hot and humid seasons, like the Gulf Coast, became glaringly apparent. MHRA took two actions. First, in support of a short-term remedy, MHRA hired Integrex (a division of Owens Corning) to

establish through testing the permeance values of various typically used interior wallboard and interior finish wall materials. MHI, a sponsor of the work, submitted the results to HUD in support of a proposed waiver in the federal standards that would allow the wall vapor retarder to be installed on the exterior of wall insulation. This means that the vapor retarder would be located on the outside—rather than the current requirement to be on the living space side—of the insulation.

Coming up with a more all-purpose solution to the moisture problem in this climate is a complex building science challenge as there are several factors that independently or in combination can trigger moisture-related building damage. To get to the root causes of and craft solutions to a problem with several contributing factors, MHRA in partnership with HUD launched a project that will collect data from about 100 homes along the Gulf Coast. The data will be used to prioritize factors that contribute to moisture problems and help researchers test abatement strategies. The product of the research will be a series of detailed recommendations that will help industry better control—through design, manufacture, and set up—the moisture-related durability and performance of their homes.

The next year will also see work start on some exciting new projects. Among them are the following: research into the expanded use of adhesives and sealants in home manufacture, assessment of home ventilation strategies, performance of unventilated attics in hot, dry climates and an initiative with manufacturing plants to help improve the design and performance of air distribution systems. MHRA will also complete work this year on the Energy Star Guide for Manufactured Homes, a road map for any manufacturer or retailer interested in tapping into the potential market for selling homes that carry the federal energy efficiency labels.

It is interesting to note that in a year that saw two industries, manufactured housing and Internet e-commerce, suffer reversals, they are businesses at the ends of the technology spectrum. Web businesses feed off of and literally exist by virtue of our technological prowess and vitally depend on the immediate application of cutting-edge innovation. Manufactured housing is just discovering, in a profound way, the advantages of applying the fruits of research and development. In both cases, recent difficulties can be viewed as part of a maturation process from which stronger industries will emerge.

With this issue of **TECHNOLOGIES**, I pass the torch to incoming MHRA Chair, Rick Boyd. Rick is Vice President of Manufacturing Operations with Clayton Homes and a founding member of the Research Alliance. I could not think of a more capable pilot for MHRA as we launch into the third millennium.

John Bishop, Chair

From the Ground Up: Emerging Trends in Foundation Design

All buildings need adequate support. Since humans began erecting shelters, this has been the unwavering basis behind the design and construction of long-lasting homes.

This fully-formed concrete perimeter wall with interior chassis supports is fully recessed (dug out). Backfilling will happen after the house is rolled on.

However, when the clever idea of building homes in factories grew, the importance of proper support for them became somewhat diminished. It was no longer necessary to build the foundation before building the home. Today, manufactured homes are becoming more sophisticated, more accepted and more widely used in lieu of on-site residential buildings. At the same time, people are recognizing the need to re-prioritize the foundation as a prerequisite to delivering a long-lasting manufactured home.

Manufactured home design improvements are racing along at a faster and faster pace. Homes are getting bigger, heavier and even taller. The industry, whose output was once primarily modest single section homes, is finding eager markets for homes that are substantially different from their predecessors. Any observer who would have been absent from the scene for the last 10 years would truly be astounded at the rich variety of homes now being constructed on a regular basis. And there's more to come.

Manufactured homes are wider—up to 18 feet in some states, and 16 feet in many others. They're heavier, too. Lightweight building materials of the 1970's and 1980's, such as metallic roofing, aluminum sheet siding and luan plywood interior paneling have given way to composition shingles (sometimes of the upgraded architectural variety) on plywood roof sheathing, hardboard exterior siding (and vinyl siding over sheathing) and drywall interiors. More complex floor plans and the greater use of higher quality and heavier doors, windows and cabinets, among other components, add substantially to the weight and mass of the home.

Two story homes, once almost unknown in the industry, are making inroads in some niche markets. All of these factors are part of accelerating series of developments that are narrowing the gap between site-built homes and manufactured homes.

But big, heavy houses demand substantial foundations to give them the support they need for long life, durability and the safety of their occupants. In some instances, advances in the design and acceptability of such foundations have not kept pace with the homes they are intended to support. Without the adequate transfer of load to the foundation, and a foundation design capable of carrying the increased load, the weight on the home's perimeters will cause sagging floors, cracking sheetrock and misaligned doors and windows.

In spite of this, persistent industry customs have sometimes delayed the widespread implementation of quality foundation systems in the name of cost savings and economy for affordability purposes.

New home designs and “conventional” site developers—using manufactured homes in lieu of site-built homes—have brought fresh perspec-

This foundation has a perimeter wall and interior pier supports. It is not recessed because of the lot's excessive upslope relationship to the street.

tives on the importance of foundation thinking. Further, industry research projects are encouraging steady progress in the challenge of making heavy-duty foundations more cost effective.

Before these changes in manufactured home designs and applications, it was standard practice to merely support the homes on the main beams of their steel chassis and at designated points along the center mating line of multi-section homes. Comprised mostly of stacks of concrete blocks, or of manufactured steel stanchions, these installations were retained because they were extremely inexpensive.

Over time, homes began to gain extra support from occasional exterior wall piers, and were increasingly secured to the ground by various types of anchoring devices, helping the homes resist wind and earthquake movement. Some of these improvements were voluntary, or market-driven, while others were mandated by regulation.

With the increased use of manufactured homes by conventional builders and developers—in an effort largely intended to solve some of their own construction problems—the adaptation of "conventional" home foundation systems for manufactured housing installations is accelerating. Zoning barriers are being struck down by more progressive states' legislatures and manufactured homes are finding their way into urban subdivisions and infill sites. Here, real estate construction standards are forcing changes in foundation and installation practices. Approximately 20 years ago, the first manufactured home structural concrete foundations began to be devised and refined. Builders and developers, along with home buyers and mortgage lenders, required systems which were the functional equal to foundations they regularly used with raised-floor site-built homes.

In other areas, foundation designs were created to solve problems with frozen and expansive soils, and in markets demanding full basements.

Clever Thinking Leads to Innovations

Complicating matters is the long-standing ruling by HUD that the removal of the chassis is a violation of the enabling legislation. This forces innovators to make the best of a heavy structure base—one that is well suited for its role in safely transporting the house but becomes an obstacle to cost-effective long-term support as part of a structurally-integrated foundation system.

Installers and builders presently have no choice but to work with the substantial floor frame, incorporating it into all types of foundation systems. In one instance, a manufacturer has integrated the

Foundation Design continued on page 6

Shown below is a perimeter wall , footers and redwood posts for chassis. It is not recessed and will have a framed load bearing wall connecting the floor to the foundation wall (pony wall) secured with anchor bolts.

Foundation Design continued from page 5

chassis into the floor system. The wood joist assembly, normally resting atop the chassis, is eliminated. Then the frame system is modified greatly to perform the roles of both the chassis and the subfloor. Thick flooring is attached directly to the wood and steel frame.

Almost all manufacturers offer optional floor/chassis systems in which the steel chassis is recessed far enough from the edge of the wood floor assembly to permit the home to be installed right on top of the sill plate of a perimeter foundation. In such a placement, the chassis fits inside the foundation walls. This is especially desirable when the intent is to bring the home as low to the ground as possible.

Meeting Local Conditions and Market Demands

Northern areas with deep frost line conditions have presented especially tough challenges to those who wish to place homes on non-relocatable foundations, but find deep excavations and large quantities of concrete too expensive for their construction budgets. Here, the floating slab has been developed and refined for manufactured home use.

A full concrete slab, with a load-bearing or nonload-bearing wall around the perimeter, and piers under chassis beams and under the centerline, supports the entire home. The home is structurally tied to the slab, effectively creating an integrated structure that, as its name implies, rides on the soil to withstand freezing and thawing cycles. Special attention is paid to minimizing frost penetration under the slab. The attachment of garages to the homes present the challenge of resisting any differential movement.

In climates that are not subject to freezing soils, the use of a concrete structural perimeter stem wall foundation with interior support piers has become pervasive. This system closely resembles foundations that are constructed for site-built homes. The foundation exterior is an inverted "tee" design extending six to eight inches above the ground, capped with a mud sill secured to the concrete with anchor bolts. Along the chassis beams and at the centerline are individual footers for pier support. The manufactured home, with a recessed chassis, is attached to the perimeter mud sill by nailing shear strips connecting the floor joists to the sill.

This system is especially popular with developers intent on dropping the home to its lowest possible position for the sake of aesthetics. The full perimeter walls prevent water from flowing under the house and provide continuous support to the entire home exterior.

Basements are demanded by homebuyers in a broad swath of the country's midsection. Manufacturers in these regions have long supplied optional floor systems which allow for stairwells and for clear span support under the home. A forest of columns in a manufactured home basement would render the basement unusable.

Here, the use of various combination floor/chassis systems enables the home to span from the edge of the floor to the centerline, reducing the number of support columns to an acceptable single row where the floors come together. Similar to the perimeter wall foundation, the basement gives the house a full and continuous support around the entire perimeter.

Often times the option of the integral floor/chas-

This site is ready for delivery of the home through the front endwall. Prior to delivery, the pony walls and posts will be set aside, then reinstalled to support the home.

The unattractive exposed I-beam is the result of not recessing the chassis and not providing an adequate trim detail.

sis system is not available from the manufacturer. In this case, basement designers have developed structures that feature heavy steel cross beams, set into pockets formed in the exterior basement walls. The manufactured home chassis rests directly upon the steel cross beams as the perimeter of the wood floor sits on the exterior sill.

Continuing Advancements

The market forces, which have led to these foundation concepts will accelerate and shape industry thinking far into the future. Each builder and developer who comes to this industry brings ideas and practices from their routine building business. Some systems are proven unworkable while others break new ground and will eventually go into widespread use.

The manufactured housing industry itself, through MHRA's Alternative Foundation Systems project, is looking at current practices in all parts of the country and documenting the best of these foundation solutions. The project, to be completed late this year, will uncover clever and effective systems, and promote the greater use of first class foundation designs.

Manufactured homes are going to grow further in size, substance and weight. Foundation innovations will benefit the industry through a more positive public image, by greater acceptability by local zoning regulators, homebuyers and mortgage lenders, and by reduced warranty costs.

But the greatest beneficiaries of all will be the home buyers themselves, who will enjoy manufactured homes that will have even fewer maintenance problems, longer useful lives, and higher resale values.

–Steve Hullibarger

About the author:
Steve Hullibarger is President of the Home Team, a professional consulting firm for manufactured housing development. Hullibarger's 28 years of experience in the manufactured housing industry includes a background in manufacturing, development, and marketing operations.

Get Involved

Alternative foundations project

MHRA extends a special invitation to retailers and installers who have foundation designs they would like to be included in the alternative foundations study. This is an opportunity for companies or individuals to work with MHRA in refining their foundation systems for manufactured homes. If you would like to take part in this project please contact: Ian Klose at MHRA, 220 West 93rd Street, New York, NY 10025; (212) 666-7771; or jklose@research-alliance.org.

MHRA to work with plants on duct performance

As the next phase in our continuing efforts to assist manufacturers interested in improving the performance of their duct systems, MHRA will arrange for professional diagnosticians and air distribution systems experts to visit 20 plants across the nation. The experts will work with plant staff in gauging the efficiency of current duct systems and recommend changes in design and installation practices that will improve performance. Manufacturers interested in participating in the program should contact: Ian Klose at MHRA, 220 West 93rd Street, New York, NY 10025; (212) 666-7771; or jklose@research-alliance.org.

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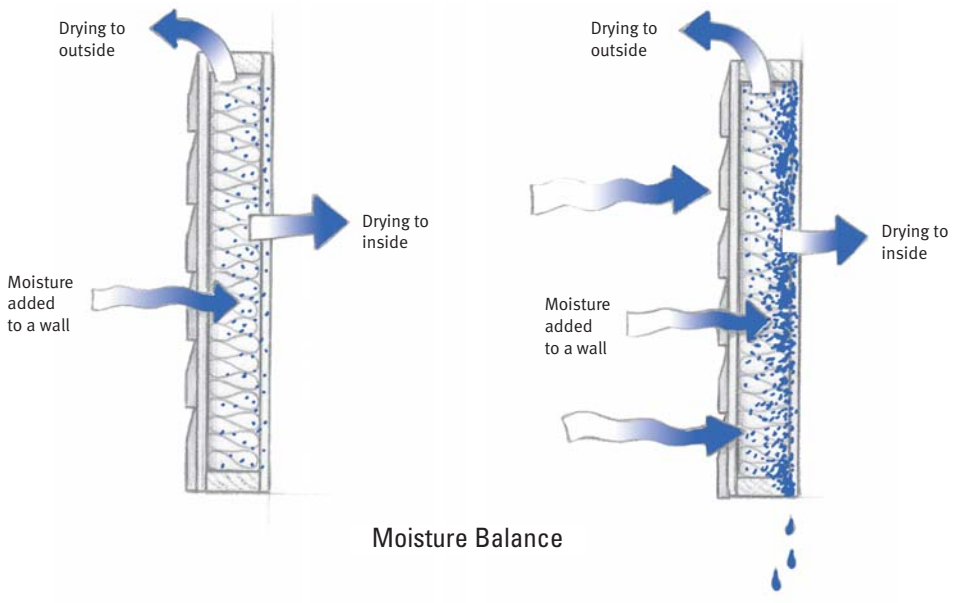


Balanced: The wall can store some moisture as long as it can dry out.

Unbalanced: Moisture is added faster than it can dry out accumulation and damage occurs.

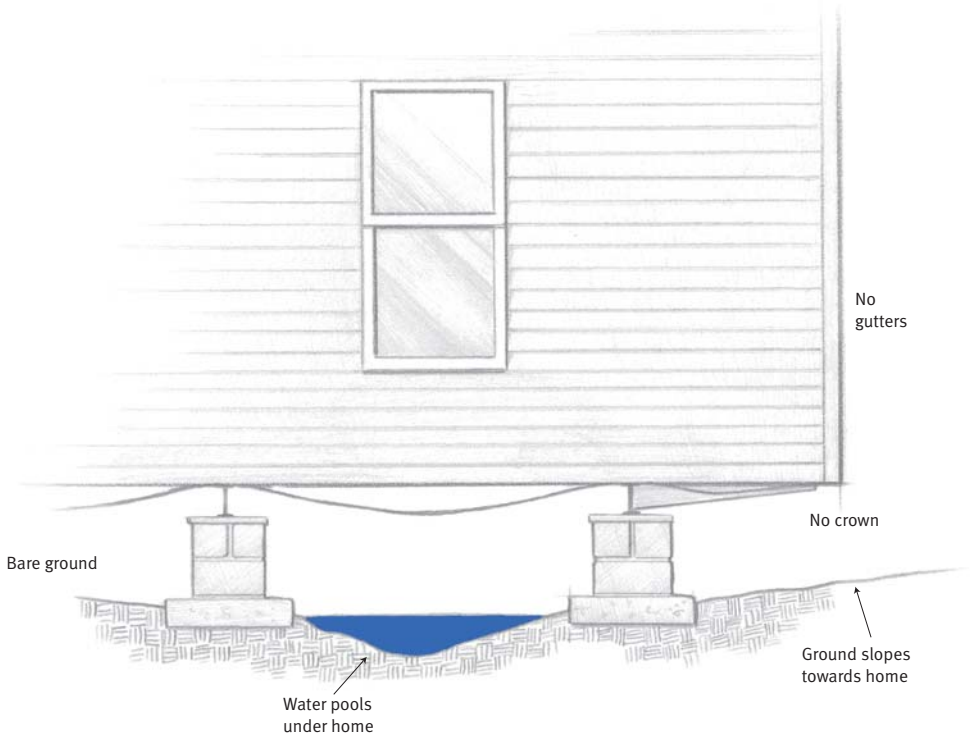
This heavily illustrated guide covers steps that can be taken to prevent moisture problems from occurring, curing problems that do occur and understanding the building science of moisture flow and accumulation. Easy-to-use checklists are included to help recognize proven strategies for preventing moisture problems. Practical examples and case studies illustrate symptoms, causes and remedies of specific moisture problems.

Decisions are made at every stage in the life cycle of the home that influence whether or not the home will experience moisture problems: in home design and construction; during set up; and in the way the home is operated. The MHRA moisture guide makes clear that the decisions and actions of the manufacturer, installer and homeowner all play key roles in assuring that moisture does not accumulate on building surfaces and within building components causing discoloring, damage and possibly building system failures.

Avoiding Problems Through Design and Construction

Moisture Problems in Manufactured Homes: Understanding Their Causes and Finding Solutions suggests how and why manufacturers are the first line of defense against moisture problems. With loads of case studies and illustrated examples, manufacturers are shown how to take into consideration the most important factors that will impact the tendency of moisture to accumulate and cause future problems, and the role of the manufacturer in helping the installer and homeowner recognize their contribution to minimizing such problems.

A properly graded site has a crown underneath the home and sloping ground that carries water away from the house, unlike the poor grading job shown below.



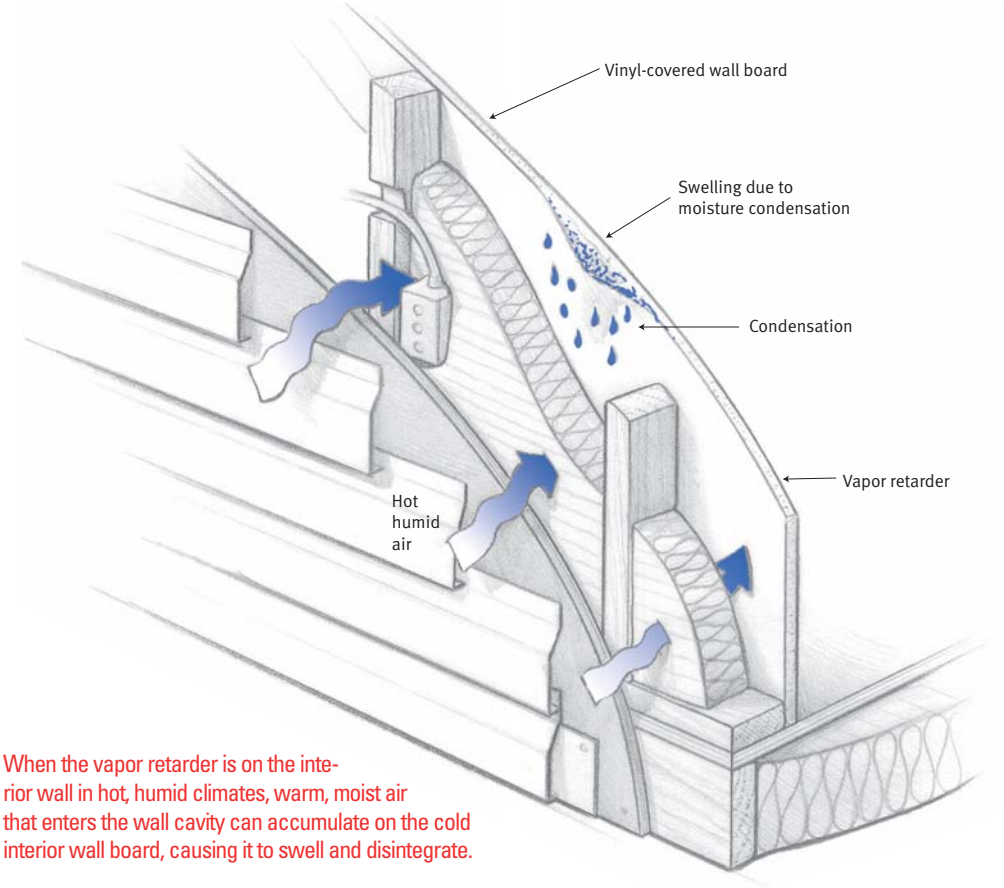
By taking a few extra precautions during the design and home production stage, manufacturers can significantly reduce moisture risk, at little added cost.

Avoiding Problems Through Setup

The guide clearly documents and demonstrates that even the best design for moisture control can be compromised by common errors made in home installation. Although manufactured homes are primarily built in a factory, on-site installation crews handle critical tasks that will impact the home's future moisture balance.

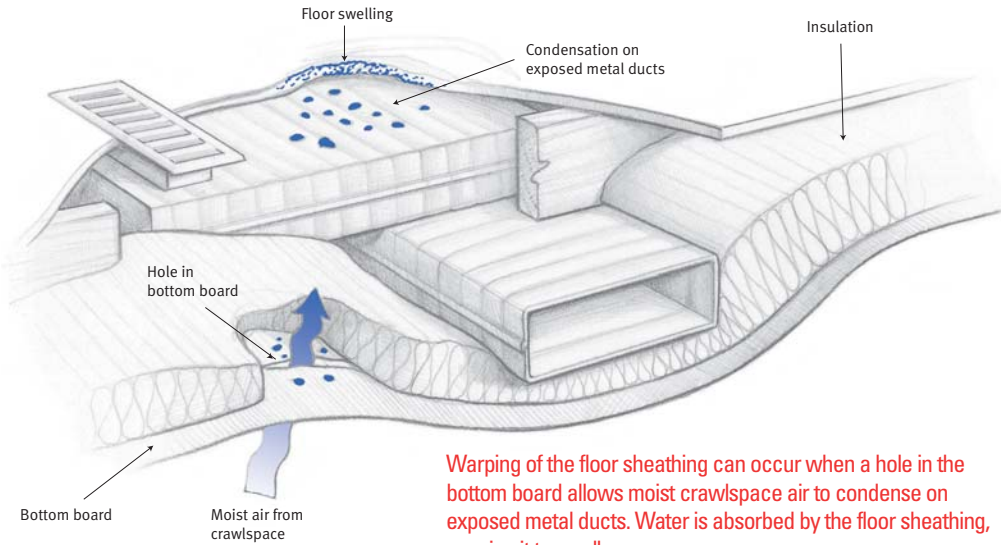
The quality of the setup can contribute to home comfort, durability, and efficiency or result in discomfort, high-energy costs, and moisture problems. The installation can easily tip the scales in either direction.

Setup is a difficult task. It is dirty, dangerous, and demanding. Completion deadlines often require intimate knowledge of several manufacturers' installation instructions; work in confined spaces; and a knack for simultaneously satisfying manufacturers, retailers, state inspectors, and homeowners. Just as in manufacture, a poor installation can defeat even the best planning. Given the financial pressures of completing the setup quickly, it can be tempting for a setup crew to take shortcuts that have a negative effect on the moisture balance.



When the vapor retarder is on the interior wall in hot, humid climates, warm, moist air that enters the wall cavity can accumulate on the cold interior wall board, causing it to swell and disintegrate.

Among the steps the set-up crew can take to avoid moisture problems described in the guide are the following: properly grading the site to shed water, installing a ground cover, properly sealing the marriage line, attaching the cross over duct securely and with a



Warping of the floor sheathing can occur when a hole in the bottom board allows moist crawlspace air to condense on exposed metal ducts. Water is absorbed by the floor sheathing, causing it to swell.

Moisture Problems continued on page 12

Sizing Up the Sizing Charts

Evidence is beginning to come in from the field that the Cooling Equipment Sizing Charts are having their intended impact. As reported in prior issues of **TECHNOLOGIES**, the sizing charts offer HVAC specifiers guidance on properly sizing heat pumps and air conditioners.

Prior to the use of the sizing charts, many cooling equipment specifiers depended on outdated rules of thumb to size equipment, often resulting in equipment that was oversized by ½-ton or more of cooling capacity. For example, when Tennessee Valley Authority (TVA) launched a very aggressive effort to get equipment specifiers to use the charts as part of their Energy Right program, the average capacity of cooling equipment being installed in Tennessee stood at about 3.25 tons. Today, the average is closer to 2.65 tons, a dramatic reversal that reduced the equipment cost and is saving homeowners plenty on their energy bills.

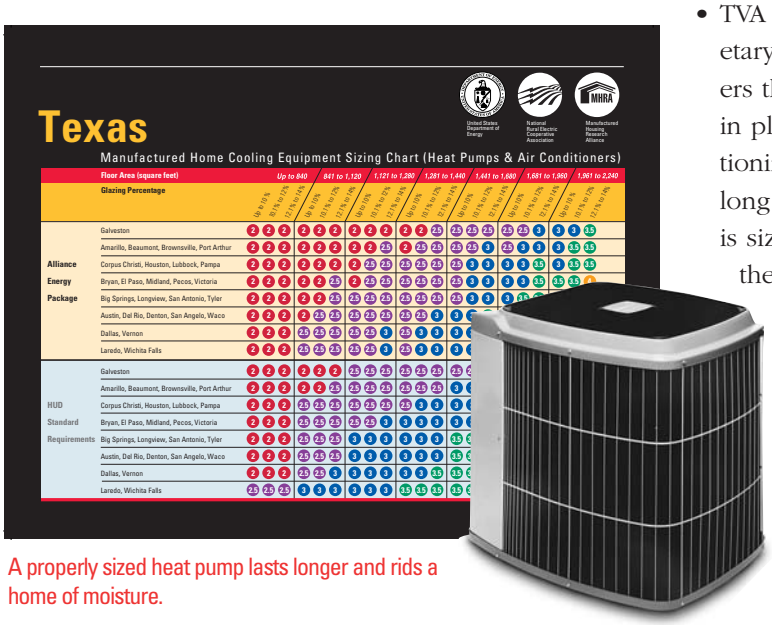
> *"Oversized air conditioners and heat pumps is recognized as a common industry problem eroding energy efficiency and lowering customer satisfaction."*
>
> Terry McIntosh, TVA

According to TVA's Terry McIntosh, oversized air conditioners and heat pumps is recognized as a common industry problem eroding energy efficiency and lowering customer satisfaction. The problem with over sizing is that consumers pay for equipment that costs more and has more cooling capacity than they need. Oversized equipment cycles on and off frequently, resulting in a higher utility bill, lower efficiency, as well as a shorter life span of the unit. Further, oversized equipment is a contributing factor to moisture problems.

For McIntosh, the sizing chart is the essential tool he needs to close the sale. But, he argues, changing deeply entrenched habits, like specifying equipment with too much capacity, requires persistence and a hands-on approach with retailers and equipment suppliers. His approach includes:

- Periodic meetings with retailers and their sales staff, as well as follow-up phone calls.
- Furnishing each sales center and HVAC distributor with copies of the sizing charts, and making sure that copies are available for new sales people.
- Training sales people—discussing right sizing and the value of using the chart from both the customer and profit perspective. He explains how the dealer benefits by increasing the number of customers, as well as the profit margin on the home.
- TVA also offers a monetary incentive to retailers that sell heat pumps in place of air conditioning equipment, as long as the equipment is sized according to the charts.

For those companies that do not have staff that can spend time in the field meeting with

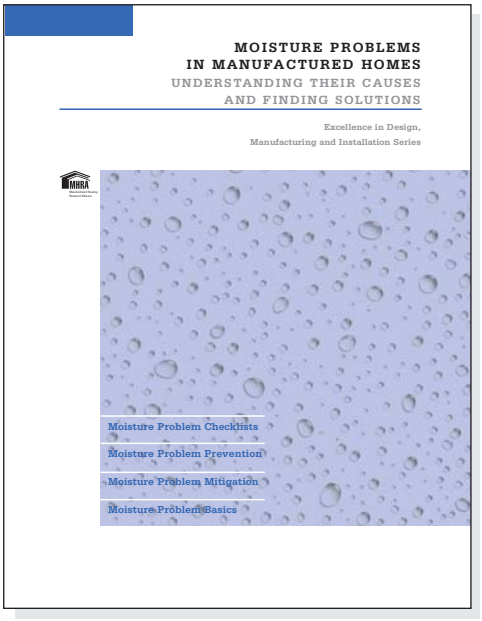


A properly sized heat pump lasts longer and rids a home of moisture.

Sizing Charts continued on page 12

Featured publication

- ***Moisture Problems in Manufactured Homes: Understanding Their Causes and Finding Solutions,*** This 60-page guide is designed to assist manufacturers, retailers, setup crews, and homeowners in recognizing and solving moisture problems in manufactured homes. This guide provides information on how to determine moisture sources, movement, and accumulation, whereby solving current moisture problems and preventing new ones. See the feature article in this issue of **TECHNOLOGIES.** (Members, $35 plus shipping; non-members, $50 plus shipping.)



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.)

- ***Cooling Equipment Sizing Charts,*** 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 for use in different wind zones and for different 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 then indicates 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.)

Requests for copies of any of the above material should be directed to the Manufactured Housing Research Alliance, 220 West 93rd Street, New York, NY 10025, (212) 666-7771; (212) 666-5389 (fax); info@research-alliance.org (email).

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permanent connector, and properly sizing cooling equipment (see story on page 10).

Avoiding Problems Through Operation

Homeowners who are usually the first to experience any symptoms of moisture problems will find this guide enlightening, particularly if they assume that they have no role in avoiding moisture damage. The guide teaches homeowners how to avoid moisture problems by proper care and operation of their home. It also helps homeowners recognize problem symptoms so they can be addressed quickly, correcting small problems before they become big ones. This is especially important for people with allergies or asthma, conditions that might be exacerbated by mold and mildew brought on by moisture buildup.

The guide delves into actual case study examples of homes that have experienced moisture-related damage and the actions taken to remedy the damage. It also describes the basic building blocks of moisture dynamics: moisture source, movement, and accumulation.

Moisture Problems in Manufactured Homes: Understanding Their Causes and Finding Solutions is available from MHRA (see the MHRA Publications list on page 11 of this issue of **TECHNOLOGIES**).

Sizing Charts continued from page 10

retailers, McIntosh recommends working with the state manufactured housing association in developing an outreach program. "This is one effective and credible way to further promote the use, as well as convey the importance of the equipment sizing charts," said McIntosh. "The sizing chart is a good tool, but the way in which it is delivered communicates its true value."

Charts are now available for 22 states: AL, AR, AZ, CO, FL, GA, IL, IN, KY, LA, MS, NM, NY, NC, OH, OK, OR, PA, SC, TN, TX, and VA (see Publications on page 11 of this issue of **TECHNOLOGIES**).

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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