

On February 14, 2008, the Centers for Disease Control (CDC) and Federal Emergency Management Agency (FEMA) released preliminary findings on formaldehyde testing in manufactured buildings such as travel trailers and manufactured homes. As a result, questions have been raised in North Carolina about formaldehyde, especially in mobile classrooms.

Mobile classrooms, manufactured homes, and travel trailers are different classes of manufactured buildings. Mobile classrooms, and all structures used as classrooms, must meet requirements of the North Carolina State Building Code for educational occupancy. Manufacturers of mobile classrooms must be approved for commercial construction by the North Carolina Department of Insurance, Manufactured Building Section. Mobile classrooms are often constructed with materials such as exterior grade plywood, Oriented Strand Board (OSB), Sheet Rock™ and other materials that release minimal amounts of formaldehyde.

Manufactured homes are designed and intended to be used as dwellings when connected to utilities such as plumbing and electricity. Manufactured homes must be greater than 320 square feet in size and built according to codes issued by the United States Department of Housing and Urban Development (HUD). Since 1985 the HUD code has specified a maximum allowable formaldehyde emission rate from plywood and particle board used in manufactured housing. Amendments to the HUD code in 1994 specified minimum allowable ventilation rates for manufactured homes. Newer manufactured homes tend to use sheetrock™ instead of plywood paneling for interior walls. The HUD code and new construction practices have lowered formaldehyde levels in modern manufactured homes.

Travel trailers, also known as recreational park trailers, are designed and intended for use as temporary living quarters for recreational, camping, travel, or seasonal use and may not exceed 400 square feet in size. The Recreational Park Trailer Industry Association has adopted an industry recommended practice of using particle board and plywood that meet the HUD code.

In the CDC/FEMA study, formaldehyde levels were generally higher in travel trailers compared to manufactured homes. Several factors may influence this trend including:

- Travel trailers are smaller and have a larger surface area to volume ratio than other manufactured buildings. In smaller buildings there is less air volume to dilute contaminants.
- Although use of pressed wood products that meet the HUD code is an industry recommended practice, it is possible that some travel trailers are built using materials that do not meet the HUD code and could release significant amounts of formaldehyde. Pressed wood products used in mobile classrooms meet the HUD code for formaldehyde emissions.

- Ventilation rates in travel trailers may be lower than in other manufactured buildings.
- There may be less insulation in travel trailers, which could lead to pressed wood products reaching higher temperatures in travel trailers compared to other manufactured buildings. More formaldehyde is released from pressed wood products as the temperature increases.

Consider These Factors before Testing a Building for Formaldehyde

Types of Building Materials - Pressed wood products such as hardwood plywood, particleboard, medium density fiberboard and other hardboards containing urea-formaldehyde (UF) based resins are of most concern. UF based resin wood products meeting the HUD code, with approval seals from the Hardwood Plywood Veneer Association or the Composite Panel Association, release lesser amounts of formaldehyde. Other pressed wood products such as exterior grade or moisture resistant plywood, OSB and pressed wood products containing other resins release very small amounts of formaldehyde.

Age of the building --Release of formaldehyde decreases as the pressed wood products age. As a result, buildings more than four years old will have significantly less formaldehyde than newer buildings.

Other sources of Formaldehyde --In addition to building materials there are other sources of formaldehyde in buildings. Formaldehyde may be found in furnishings, such as cabinets made with particle board, and permanent press draperies. Formaldehyde is a combustion product released by gas appliances, wood stoves and fireplaces. It is also a component of tobacco smoke. Formaldehyde may also be found in some paints, sealers, glues, adhesives, fingernail polish and hardeners, cosmetics, fabric softeners and other consumer products.

Ventilation, Temperature and Humidity --The concentration of formaldehyde indoors will be influenced by the design and operation of ventilation systems. Formaldehyde levels will be lower in structures with continuous natural or mechanical ventilation that brings outdoor air into the building. Increasing temperature and humidity in a building increases the release of formaldehyde from wood products. Maintaining a building at a comfortable temperature and humidity (72-75°F and 30 to 50% relative humidity) will decrease the release of formaldehyde. Formaldehyde may accumulate in buildings that are sealed and not in continuous use, especially if the outdoor conditions are hot and humid.

Coatings -- Pressed wood products coated with water resistant sealants and paints, whether in the factory or field, tend to release less formaldehyde, especially if the back, sides and edges of the materials are coated.

Health Effects of Formaldehyde

Inhalation of formaldehyde can cause a variety of health effects. Moderate levels of formaldehyde are irritating to the eyes nose and throat. At high levels chest tightness, coughing and wheezing can occur. Potential health effects depend on the level and duration of exposure, as well as individual sensitivity and susceptibility. The formaldehyde level at which an individual will experience health effects is variable. Some people are more sensitive and will react at lower levels or have more severe reactions than the general population, especially after repeated exposures. Susceptibility refers to the potential for certain groups of people to be more likely to have adverse health effects from an exposure. For example children, the elderly, people with allergic conditions and people asthma may be more likely to experience adverse health effects from exposure to formaldehyde than healthy adults. The level at which people can detect the odor of formaldehyde is variable, ranging from 50 to 500 parts per billion (ppb) of air.

Testing Issues

An assessment of potential sources of formaldehyde and effectiveness of ventilation should be performed before deciding to test a building for formaldehyde. Well ventilated buildings constructed of materials that release small amounts formaldehyde do not need testing. Testing may be indicated in buildings with numerous or large sources, especially if the building is poorly ventilated or if the unique pungent smell of formaldehyde is detected.

If testing is performed, there should be a plan to interpret results. One issue is determining a “safe” level of exposure. There is a wide range of published levels of concern for formaldehyde exposure depending on the duration of exposure, exposed population and target health effect. The general consensus is that levels of formaldehyde less than 50 ppb are considered to be a low risk for adverse health effects. Levels of formaldehyde between 50 ppb and 500 ppb are considered to be an intermediate risk and steps should be taken to reduce exposure. A formaldehyde level above 500 ppb is considered to be a high risk and a priority should be placed on reducing formaldehyde levels, especially if young children, the elderly or people with asthma are exposed.

The urban background concentration of formaldehyde has a reported range of 8 to 68 ppb. Background concentrations near heavy traffic may be as high as 80 ppb. Formaldehyde measurements in buildings where smoking is not permitted have ranged from “undetectable” up to 22 ppb. Formaldehyde levels where smoking is permitted have ranged from “undetectable” up to 60 ppb. Levels in manufactured homes have been reported to be as high as 80 ppb in the winter and 90 ppb in the summer. According to the Manufactured Housing Institute, there have been no published scientific studies of formaldehyde in operating manufactured homes constructed since the implementation of the HUD code that measured levels of airborne formaldehyde above 100 ppb.

Reducing Formaldehyde in Buildings

Regardless of testing, formaldehyde levels should be reduced in buildings. The best methods to reduce formaldehyde in any building are to remove or reduce sources and avoid adding new sources. If the structure has bare urea formaldehyde wood products, coating the materials with several layers of water resistant sealants on sides and edges may reduce emission of formaldehyde. Good ventilation is needed if sealants and coatings are applied and for several days afterward. In addition to building materials, some paints, wallpapers, glues, sealants, permanent press fabrics (draperies) and furniture made with pressed wood products can emit formaldehyde. Permanent pressed fabrics and furniture can be aired out before installation. Tobacco should be consumed outdoors. Combustion appliances should vent directly to the outside. Temperature and humidity should be controlled to comfortable levels as the amount of formaldehyde released from building materials increases as the temperature and humidity rise.

Conclusion

Mobile classrooms, manufactured housing and travel trailers have differences in building materials, furnishings and ventilation requirements that influence formaldehyde levels. Mobile classrooms, especially those constructed with OSB, exterior grade plywood, gypsum board (drywall or sheetrock™), fiberglass reinforced plastic, fiberglass bat insulation and vinyl floor tiles, are likely to have the lowest levels of formaldehyde due to lack of sources and high ventilation rates. Manufactured homes may have higher formaldehyde levels because of additional sources of formaldehyde such as furnishings and consumer products and less ventilation than mobile classrooms. Travel trailers are likely to have the highest formaldehyde levels due to a large surface area to volume ratio, use of building materials that may release larger amounts of formaldehyde, furnishings and consumer products that may release formaldehyde, and low ventilation rates.

Formaldehyde levels may be lowered in all buildings by reducing or removing sources, increasing ventilation, maintaining moderate temperature and humidity, venting combustion appliances outdoors, and prohibiting tobacco smoking indoors. These practices will have the added benefit of improving the general indoor environment.

If you have questions, please contact staff at the Occupational and Environmental Epidemiology Branch at (919) 707-5950.

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