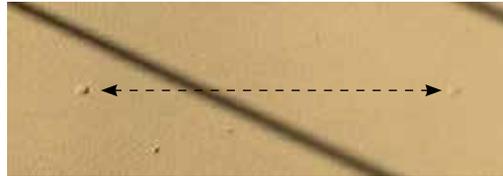


# USG FASTENER-RELATED DRYWALL INSTALLATION ISSUES AND RECOMMENDATIONS

In the last two to three years, USG has received a significant number of fastener-related drywall installation complaints in the Mid-Atlantic region (Virginia, Maryland, Pennsylvania, New Jersey and New York). Numerous drywall contractors within this region have reported raised bumps over drywall screws occurring anywhere from a few days to several months after hanging and finishing the drywall as shown in figure 1. The reports were specific to wood-framed residential construction finished with 1/2" USG Sheetrock® Brand UltraLight Panels with limited occurrences reported on 5/8" USG Sheetrock® Brand Firecode® Core Gypsum Panels.



**Figure 1:** Drywall screw bumps

In order to assess the situation, USG representatives visited with drywall contractors on various job sites in the Baltimore and Philadelphia markets. The drywall contractors described these fastener problems as a raised circular protrusion or bump directly above the fastener similar to a “Nail Pop.” These bumps or “Screw Buttons” would occur randomly throughout a given home and were not tied to any specific wall (exterior, interior, ceiling, stairwell, etc.). They would appear anywhere from a few days to several months after hanging and finishing the drywall. After an extensive evaluation of the drywall installation process, the following commonalities were identified:

1. All residential wood-frame construction
2. Primary drywall used was 1/2" USG Sheetrock® Brand UltraLight Panels
3. All drywall contractors used standard drywall screws
4. All drywall contractors used low-VOC water-based drywall adhesive
  - a. This adhesive was primarily used in the field of the panel and not at the taper or butt joints
5. The drywall screw buttons only occurred in the field of the panels

## TESTING

Based on these findings, a test protocol was developed in an effort to replicate the complaint phenomenon. Wood-framed walls were constructed 16" o.c. with 1/2" USG Sheetrock® Brand UltraLight Panels on one side of the open wood frame, drywall screws, and the brand of low-VOC water-based adhesive most used in the affected market applied in a 3/8" bead in the field of the board only. The control wall utilized the same materials, but without any adhesive. All drywall screws were finished with three coats of drywall compound the same day the panels were installed in lab conditions at 68°F and 76% RH. Within 24 hours, the screw buttons formed in the field of the panels installed with adhesive and none occurred on the control panel. A second round of testing was conducted to disprove theories heard in the field that these screw buttons were directly related to 1/2" USG Sheetrock® Brand UltraLight Panels (1250 lbs/msf). The second test used 1/2" USG Sheetrock® Brand Regular (1450 lbs/msf), 5/8" USG Sheetrock® Brand Firecode Core (2200 lbs/msf), 5/8" USG Sheetrock® Brand Abuse-Resistant Firecode Core (2800 lbs/msf), Georgia-Pacific ToughRock® Lite-Weight Gypsum Board (1450 lbs/msf), and National Gypsum Gold Bond® High Strength LITE® (1400 lbs/msf). The drywall was installed and finished in the same manner at 68°F and 83% RH lab conditions. Within 24 hours, screw buttons formed in the field of all panels with drywall screws and the adhesive. The control walls did not form any screw buttons. These results showed that the stud or wallboard type was not a factor in the protrusion and also that the use of heavier drywall is not a solution to this problem. It identified the issue to be the use of adhesive.

## TESTING CONT.

To gain further understanding of the problem, a third round of testing was conducted to determine if other low-VOC water-based drywall adhesives are behaving the same, how a solvent-based drywall adhesive behaves, and what happens if you allow the low-VOC water-based adhesive to fully cure prior to finishing the screws. 1/2" USG Sheetrock® Brand UltraLight Panels were installed and finished in the same manner as the first round at 68°F and 76% RH lab conditions with two additional brands of low-VOC water-based drywall adhesives. Within 24 hours, screw buttons formed in the field of the panels. 1/2" USG Sheetrock® Brand UltraLight Panels were then installed and finished as in round one testing at 68°F and 76% RH lab conditions with a solvent-based drywall adhesive. No screw buttons occurred. Finally, 1/2" USG Sheetrock® Brand UltraLight Panels were installed as in round one testing with the original brand of low-VOC water-based adhesive at 68°F and 76% RH, but allowed to fully cure prior to finishing. No screw buttons occurred.

The results of these tests have led to USG's determination that the low-VOC water-based drywall adhesives are the cause of the protrusions. In order to quantify this, a two-inch strip on the wood stud was intentionally left without adhesive during the first two test installations. Immediately after the drywall was fastened in place, a feeler gauge was used to determine whether or not there was a measurable gap between each wood stud and the drywall. The measured gaps ranged from .050 to .070 inches. After the screw buttons formed, the adhesive gaps were unable to be measured due to the fact that the drywall had moved tight up against the wood stud. This clearly documented that the adhesive shrank while it was curing and pulled the drywall closer to the wood stud. Since the drywall screw does not move, the drywall compound on top of the screw head is "pushed" out forming the protrusion or screw button. To speak more precisely, the phenomenon is caused by the adhesive "pulling" the drywall and not by anything "pushing" the screw.

To better understand the dimensional stability of these adhesives, trays fabricated with 1/2" x 3/4" x 4" cavities were filled with three different brands of low-VOC water-based and three different brands of solvent-based drywall adhesives. Each product was dried in an environmentally controlled chamber at 95°F/10% RH for two weeks, as shown in figure 2 and 3. It was observed that the surface of the low-VOC water-based adhesives shrank below the top of the 1/2" deep cavity by an average of 0.303 inches for brand A, 0.259 inches for brand B, and 0.266 inches for brand C (see figure 4), demonstrating that at least 50 percent shrinkage occurred while it was drying. This is very significant, as it relates to the formation of screw buttons. The solvent-based products shrank considerably less below the top of the 1/2" deep cavity by an average of 0.103 inches for brand D, 0.078 inches for brand E, and 0.064 inches for brand F (see figure 4).



Figure 2: Filled Tray before 95°F/10% RH

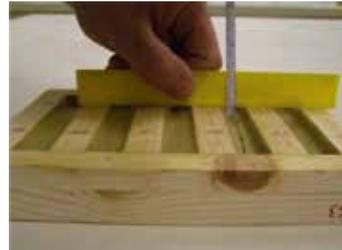


Figure 3: Filled Tray Measured after 95°F/10% RH

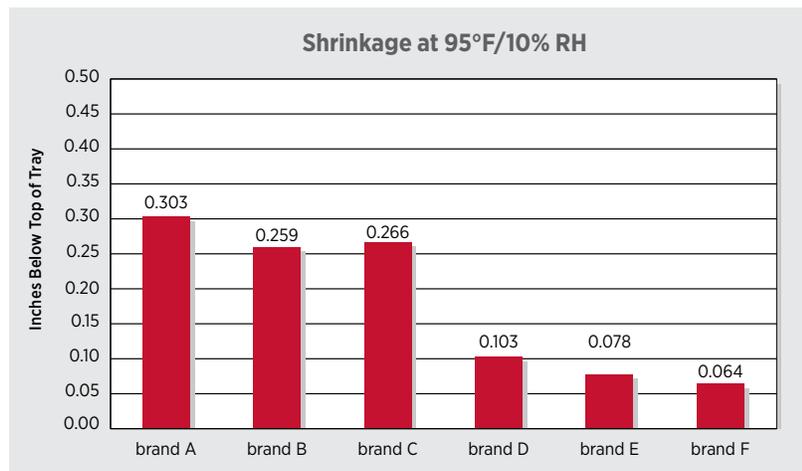


Figure 4: Water-Based vs. Solvent-Based Shrinkage

## TESTING CONT.

Additional small-scale test results illustrated that the cure time for the non-solvent-based adhesives is directly impacted by temperature and humidity levels. Each of the low-VOC water-based adhesives noted above were conditioned at 40°F/80% RH for two weeks and did not fully cure. It was observed that the surface of the low-VOC water-based adhesives shrank below the top of the 1/2" deep cavity by an average of 0.165 inches for brand A, 0.131 inches for brand B, and 0.081 inches for brand C (see figure 5). Since lower temperatures lead to delayed curing, this can considerably impact the time required for the adhesive to dry and ultimately shrink and pull back the wallboard panel. During the winter months, colder temperatures experienced in the drywall installation phase will delay the curing of the adhesive until the HVAC system is in operation. Once the HVAC system is turned on, it is still unclear how long it will take to fully cure the adhesive.

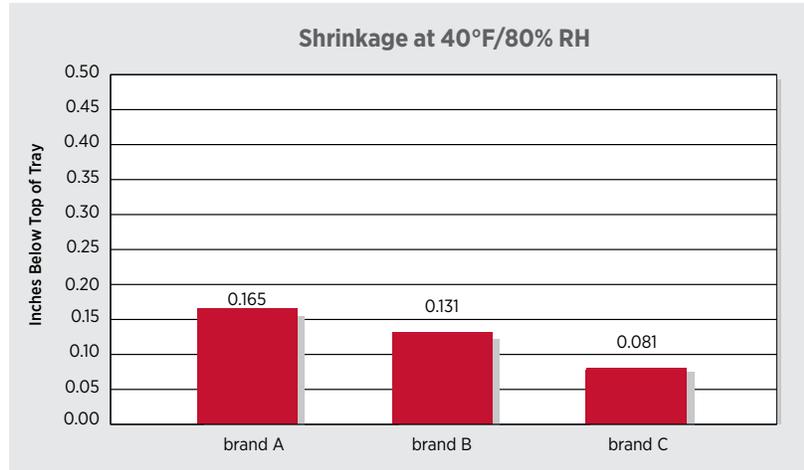


Figure 5: Water-Based Shrinkage at Low Temperature High Humidity

Other potential explanations for the field complaints USG received are that (1) the contractor put more than the 3/8" bead than recommended by the manufacturer; (2) the drywall was not pressed firmly in place; (3) the application temperature was below the 40°F minimum recommended by the manufacturer; or (4) a combination of some or all of the above factors.

## CONCLUSION

In summary, the water-based low-VOC drywall construction adhesives failure to cure and reach a dimensionally stable condition prior to finishing is causing screw buttons. Based on these findings, it is imperative that the adhesive manufacturer's application instructions are reviewed and followed at all times. The brand A's Technical Data Sheet recommends "a continuous 1/4" to 3/8" bead of adhesive" and to "position gypsum board and press firmly in place" for drywall applications. In addition, this manufacturer says: "The temperature of the product, the surfaces and working area must be above 40°F (4°C) and below 100°F (38°C) and for best performance, apply adhesive at 70°F (21°C)." This technical data sheet specifically states that 48 hours are required to fully cure their adhesive and that this cure time depends upon temperature, humidity, porosity of substrate, and the amount of adhesive used at the time of application.

In order to minimize or eliminate the occurrence of raised protrusions or screw buttons, USG recommends that the installer confirms that the adhesive has fully cured to ensure the adhesive has stopped shrinking and stabilized prior to the finishing of wallboard. If the drywall installer elects to allow the adhesive to fully cure prior to finishing, the drywall screws should be checked to ensure they are still properly set. The other recommendation is to not use low-VOC non-solvent-based drywall adhesives.

## ADDITIONAL INFORMATION

In one Mid-Atlantic market, a complaint on screw buttons included additional issues related to ridged or starved joints. The joint issue might be caused by the same adhesive phenomenon described in this paper, but USG has not tested this hypothesis.

In addition to the above findings, a thorough review of USG's white paper "Evaluating Jobsite Environmental Conditions" (J2074) is recommended to better understand the effects of poor jobsite conditions on gypsum board systems. The jobsite conditions should be maintained at or above 55°F/30% RH to minimize the effect of temperature, humidity and ventilation, and be free of moisture throughout the installation and finishing process. Failure to adequately maintain these levels and/or rapid changes in the environmental conditions can cause thermal and hygrometric movement, which can lead to cracking, ridging, bond loss, and fastener-related issues or other problems. The ideal conditions for the installation, finishing and decorating of USG Sheetrock® Brand Gypsum Panels are those that closely match the intended occupancy environment.

### PRODUCT INFORMATION

See [usg.com](http://usg.com) for the most up-to-date product information. For more information, please consult The Gypsum Construction Handbook, located at [usg.com/resource-center/gypsum-construction-handbook.html](http://usg.com/resource-center/gypsum-construction-handbook.html)

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WB2757/rev. 11-14  
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