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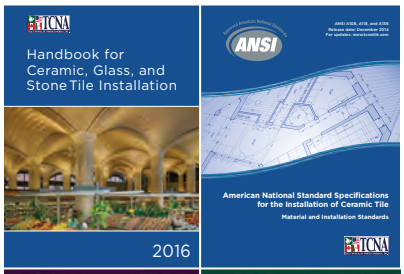

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RESEARCH SUPPORTING **AN ANSI AMERICAN NATIONAL STANDARD FOR SLIP RESISTANCE**

By Eric Astrachan

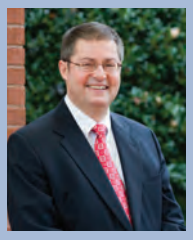
The method for measuring the coefficient of friction (COF) of ceramic tiles is specified in Section 9.6 of the American National Standard Specifications for Ceramic Tile, ANSI A137.1. The method changed in 2012 from the ASTM International test method C1028, which measured static coefficient of friction (SCOF), to the test protocol described in Section 9.6, which measures dynamic coefficient of friction (DCOF).

The transition from SCOF to DCOF has been well documented[1, 2] in previous articles by TCNA noting extensive research done in Germany and at TCNA. This article explains that research in detail. While some articles are referenced that are only available in German, the major research components from Germany are also available in English.

Although the test method described in Section 9.6 was originally written for ceramic tiles, the same general method and the same research underpinning the method are equally applicable to all hard surfaces.

German Research and Safety Standards

German safety research is a cooperative effort between the government, in the form of the German Social Accident Insurance [Deutsche Gesetzliche Unfallversicherung (DGUV)], and a host of universities, each focused on a particular area of public safety. In the field of pedestrian floor safety, the University of Wuppertal [Bergische Universität Wuppertal] has many decades of cooperation with the main DGUV research and testing laboratory at the German Institute for Occupational Safety and Health [Institut für Arbeitsschutz (IFA)] in Sankt Augustin, Germany. Their joint efforts led to the creation of German national standards—commonly referred to as DIN (Deutsches Institut für Normung e.V.) standards—for testing and certifying footwear and flooring in the laboratory. These methods, DIN 51130 (“German Ramp Test”) and DIN EN 13287 (“Floor-Shoe Tester”) have been widely used in their respective industries. In the case of the ramp test, the method has been used to make laboratory measurements of flooring for more than 20 years.[3]



Eric Astrachan is Executive Director of the Tile Council of North America (TCNA).

He is the present Chairman of the TCNA Handbook Committee, Co-Secretary of the ANSI Accredited Standards Committee A108 for ceramic tile and stone standards, and Head of Delegation for the ANSI vote on ISO TC-189, the International Organization for Standardization Technical Committee on ceramic tiles.

He is the Convener of ISO TC-189 Working Group 2 on ceramic tile standards, an elected officer of ASTM’s F13 Committee on Pedestrian/Walkway Safety and Footwear, and active on several other industry technical committees.

He is an Executive Committee member of the Board of the Ceramic Tile Education Foundation, serves on the Board of the Porcelain Tile Certification Agency, and is on the Board of Governors of the international trade show Coverings. He is also a recognized industry consultant and keynote speaker for a broad range of industry topics, including product standards, installation, international trade, and slip/fall litigation.

Following the development of the German ramp test, research was conducted titled "Experimental Investigation to Determine the Standardized Limit of the Coefficient of Friction for Slip Resistance During Walking," which was the doctoral thesis of Dr. Stefan Bönig, then a graduate student in Safety Engineering at Wuppertal.

Dr. Bönig's Research: Eight Walking Conditions

Using force plates[4] Bönig set out to empirically determine the friction necessary for safely traversing eight walking conditions:

- Walking in a straight line on a level surface
- Walking while turning
- Ascending stairs
- Descending stairs
- Walking across a ramp
- Ascending a ramp
- Descending a ramp
- Coming to a stop

Through statistical analysis of the empirical data he collected, he confirmed a normal distribution of the data and developed confidence limits for each walking condition.

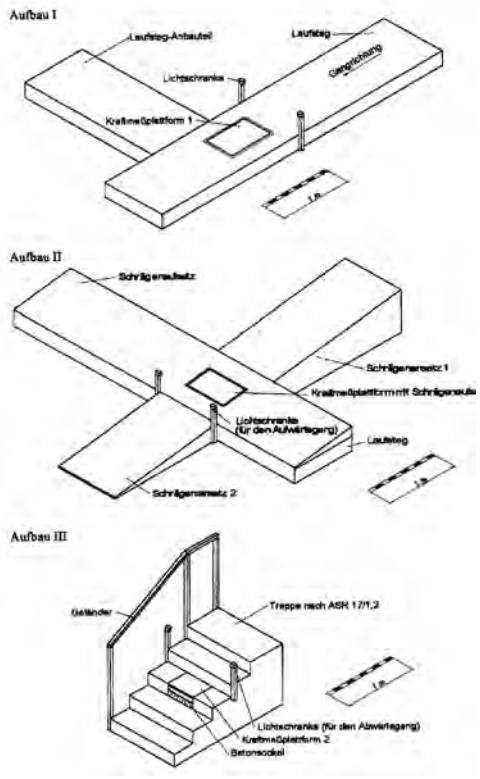
This allowed three important determinations:

1. The necessary friction for each walking condition as a function of DCOF and statistical confidence.
2. A comparison to existing accident statistics to determine the DCOF limit values for each walking condition at which accidents would be reduced for the population as a whole.
3. An evaluation of limit values for each walking condition to meet a conservative assessment of socially acceptable risk.

Preliminary Tests

Bönig conducted a series of preliminary tests to determine essential and non-essential influencing variables for this study of necessary friction.

He first looked at the relative significance of different surfaces and shoes. Two measurements were performed for each property combination of eight people, eight floor coverings, and eight shoes. This resulted in 1,024 measurements from which he determined the standard deviations of repeatability and reproducibility per DIN ISO 5725 and the relative impact of each influencing variable. Variability between the test subjects had the largest impact at 97%. The influence of the shoe and floor covering variables was 59% and 43% respectively.



Force plates were embedded into a level surface, a ramp, and on stairs to determine the friction necessary to safely traverse these conditions.

Figure: Dr. S. Bönig, Journal of Work Safety, *2/1997.*

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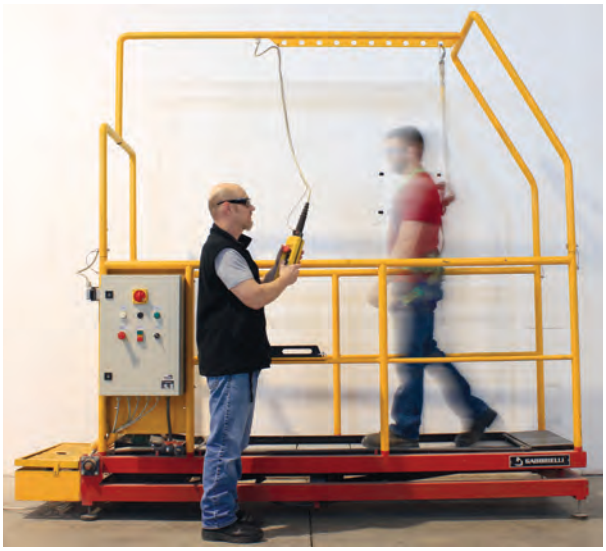

A German Ramp, similar to the one depicted above, is used in DIN 51130, and in much of the foundational research of Dr. Jens Sebald which underlies the ANSI A137.1 standard. The ramp shown is currently being used for research in the TCNA Laboratory.

Next he studied the influence of step length and step frequency. Five different step lengths were studied at three different speeds for five subjects with one repeat: a total of 150 measurements. Walking speed was determined to be an influencing variable so the main study was conducted with attention paid to the test subjects walking at their normal personal walking speed.

Böning next studied load carrying options, specifically the following:

- Walking without load
- Combined lifting and pushing (wheelbarrow)
- Carrying with both arms behind the body with a partner
- Carrying with both arms in front of the body with a partner
- Pushing an object with both arms (cart)
- Carrying with both arms in front of the body
- Carrying on one side to the right of the body
- Carrying on one shoulder

The results showed that the transport operations involving carrying in front of the body with both arms in conjunction with a partner, combined lifting and pushing, and pushing a manual cart with both arms differed significantly from walking without load in terms of the maximum COF requirement. For all other transport operations, no significant differences were observed. However, examination of the mean values showed that the transport operations that differed significantly from walking without load also exhibited a lower mean maximum friction requirement than the friction requirement from walking without load, and thus were also associated with a lower risk of slipping. Therefore, Bönig determined, in comparison to walking without load, the objective risk of slipping was not higher during manual transport operations.

Continuing his preliminary assessment of critical variables for his main study, Bönig determined eight gait models for making a turn with four combinations for stopping to determine the condition requiring the greatest friction.

Determining a Test Cohort

Since age, gender, and body height are correlated with slipping according to Skiba (1983), Skiba, Drapp, and Weider (1988), and James (1983), Bönig created a cohort of fifty test subjects based on random sampling into subsets matching the German population for age, gender, and body height.

He fixed six age and four body height categories and chose the number of test subjects based on the male/female proportion in the general population for each of the six age categories and four body height categories. As an example, he selected six females aged 20 to 30 years and seven males aged 40 to 50 years; he had four females shorter than 1.59 meters and six males taller than 1.84 meters.

Force Plate Measurements

After constructing three force plate assemblies—one for level walking, one for stairs, and one for ramps—Bönig took 2,700 force plate readings to evaluate the eight walking conditions, including a repeat of the level walking surface using the test subjects' own shoes. Three measurements per surface and per subject were made landing on the right foot and three landing on the left foot for a total of nine surfaces x 50 subjects x 6 measurements, or 2,700 total measurements.

This quantitative assessment was evaluated using Chi-Squared and Kolmogoroff Goodness of Fit tests to confirm that a normal distribution was represented in the data. This was necessary to allow a statistical analysis and an assessment of risk.

For the eight walking conditions, Bönig determined the maximum necessary friction values within a 95% confidence interval. The required friction for walking in a straight line on a level walkway was 0.31 and the required friction for traversing a ramp was 0.35. The ascend/descend stairs numbers were 0.23 and 0.26 respectively. He compared his findings, in detail, with many previously published studies and found the mean results to be in line with the ranges of the other studies. For example, a much-cited study in Britain by Harper, Warlow, and Clarke (1961) found the friction requirements for walking in a straight line, with a probability of slipping of 1 per 10^6, to be 0.36.

The figure below presents the risk of slipping for each walking condition except stopping as a function of COF. The values with 95% confidence are marked and the values for a 99% confidence interval can be seen at the intersection with the 1:100 axis.

Accident Statistics and Social Acceptability

To determine DCOF limit values for each walking condition at which safer conditions would be achieved, Bönig utilized accident data published by the German Federal Government and the Federation of German Statutory Accident Insurance Insti-

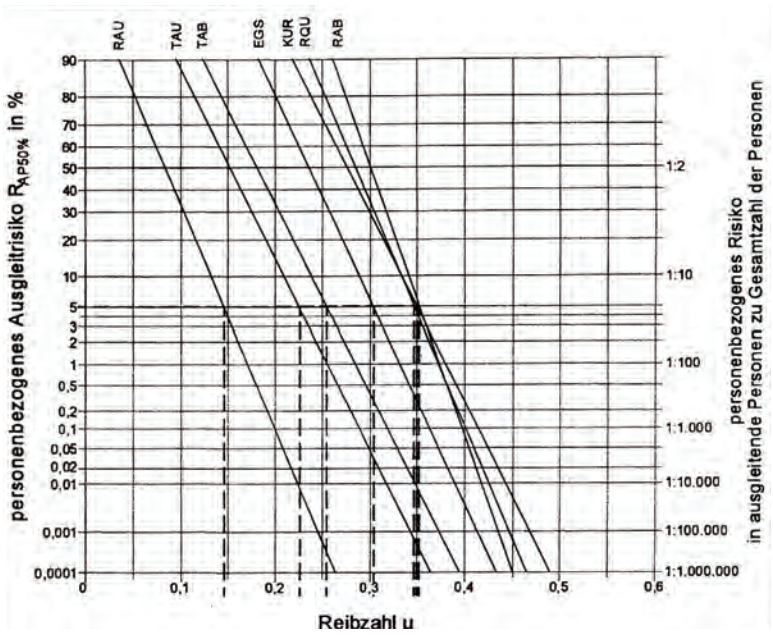

***Figure 9.3 from the doctoral thesis of Dr. Stefan Bönig**: Determining coefficient of friction from the person-specific risk of slipping as an ergonomic threshold in the form of the 95th percentile.*

personen-bezogenes Ausgleitrisiko R_{AP} in %	Person-specific risk of slipping R_{AP} in %
Reibzahl µ	Coefficient of friction µ
personen-bezogenes Risiko in ausgleitende Personen zu Gesamtzahl der Personen	Person-specific risk in number of persons slipping as a function of the total number of persons
RAU	Ascending a ramp
TAU	Ascending stairs
TAB	Descending stairs
EGS	Walking in a straight line on a level surface
KUR	Walking while turning
RQU	Walking across a ramp
RAB	Descending a ramp

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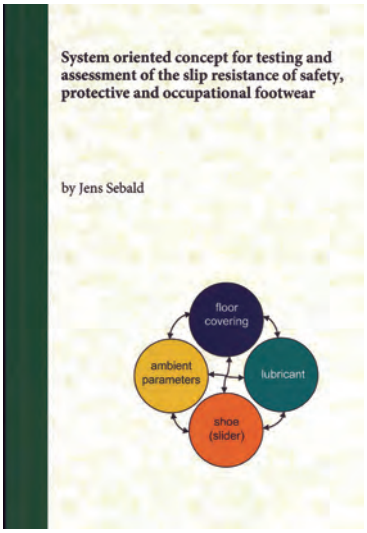

Cover of Dr. Sebald's 2007 PhD dissertation, published by Pro Business in 2009.

tutions [Hauptverband der Gewerblichen Berufsgenossenschaften (HVBG)] that provided data on all accidents in commercial companies in Germany in 1993. This data pool covered 29,688,426 German workers who walked an average of 460,000 straight line steps during the 230 working days that year. An additional 202,400 steps were estimated to have been taken by the average worker over all other walkway geometries for a total 662,400 steps per worker per year.

Based on actual statistics and some assumptions previously validated by Skiba, Drapp, and Wieder in 1988, 238,800 slip accidents occurred in 1993. Of those, 47 were fatalities, 7,458 led to disability pensions, and 23,880,000 near accidents were estimated. Using the worst-case statistical models already developed, and assuming a slip could result in an accident or near accident, that number of near accidents would occur with a straight line walking DCOF of 0.30, a descent of stairs value of 0.31, and a cross ramp value of 0.36.

Simply stated, if the friction available to German workers (i.e. that combination of shoes and flooring) should be greater than the values determined, slip events would decrease.

To determine a measure of social acceptability, Bönig assumed a conservative social acceptance risk factor per Rowe (1977) of 1 x 10-6 fatalities per year (one chance in a million), and a safe walking criteria per person of ten years. Using the accident statistics already described, Bönig calculated the necessary friction pairings to meet this social acceptability criteria: a straight line walking DCOF of 0.39, a descent of stairs value of 0.41, and a turning while walking value of 0.42.

Bönig's study was published in 1996 and was quickly adopted by his academic colleagues at Bergische Universität Wuppertal. It became known as the "Wuppertal Scale" and was subsequently added to the "Bible" of German workplace safety titled "Handbook of Commercial Safety Technology." Bönig's substantial research, subsequent research by Dr. Jens Sebald of Wuppertal, and later research by TCNA together form the basis of Section 9.6 in the ANSI A137.1 standard.[5]

Research of Dr. Jens Sebald

In 2007, Dr. Jens Sebald completed his research titled "System Oriented Concept for Testing and Assessment of the Slip Resistance of Safety, Protective, and Occupational Footwear." He studied five means of measuring COF, twenty floor coverings, three slider materials, 54 shoes, and three lubricants. The devices included in the study were the following: German Ramp, BST shoe tester, GMG 100, BOT 3000, and the British Pendulum. The floor coverings studied were ceramic and porcelain tile, quarry tile, granite, cast stone, and PVC. The sliders chosen were SBR rubber, Four-S rubber, and Picasso shoe material. The lubricants were motor oil (as used in the DIN 51130 ramp test), water with SLS surfactant, and glycerin.

While the majority of Dr. Sebald's work concerned footwear, including the measurement of footwear slip resistance and relative

comparisons of footwear, Dr. Sebald also assessed the validity of the different friction measurement methods and their suitability for transfer to devices making mobile measurements.

Simply stated, Sebald evaluated the correlation between devices under the large variety of conditions described above.

Comparing the German-engineered/U.S.-made BOT 3000 to the German Ramp, making measurements with an SBR (styrene butadiene rubber) test foot, with motor oil as the lubricant on 12 tile surfaces, Sebald determined a correlation coefficient between the methods of 0.989. Using a water and sodium lauryl sulfate (SLS) solution with an SBR test foot, he found a correlation coefficient between the German Ramp and the BOT 3000 of 0.879. The correlation between the BOT 3000 and the GMG 100 (used in DIN 51131) was 0.926, using water and SLS with an SBR test foot. These correlation coefficients mean the BOT 3000, GMG 100, and German Ramp are tightly correlated.

The same was not true for the British Pendulum, which Sebald demonstrated had a correlation coefficient with the German ramp of 0.687, when tested with SBR on 12 tile surfaces using water with SLS as the lubricant.

TCNA's Contributions to Measuring COF

In research at TCNA over a five-year period, TCNA studied the following parameters to improve the measurement of COF versus the C1028 method previously referenced in ANSI A137.1, and to assess and improve the repeatability and reproducibility of a BOT 3000 method leading to its inclusion in Section 9.6 of the A137.1 standard:

- Static vs. Dynamic COF
- Deionized water vs. SLS water
- BOT 3000 method vs. C1028 method
- BOT 3000 method vs. British Pendulum method
- BOT 3000 sensor preparation using a TCNA-developed sanding device to eliminate variation from sanding
- Measurement of 300 tile surfaces for SCOF and DCOF, concluding that 0.60 wet SCOF correlated on average with 0.38 wet DCOF.[6]
- Inter-laboratory testing of the method in Section 9.6 using seven different tile surfaces, six laboratories, and three repeats to determine and report the method's reproducibility and repeatability as detailed in the standard.

The BOT 3000E, shown here, is used for ANSI A137.1, Section 9.6, DCOF testing.

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Adoption into Standards

In January 2011, the DGUV in Germany issued its Rule Number 8687 mandating the use of DIN 51131 in combination with a wet DCOF target derived from the Bönig research.

Following the research from Germany, and the research conducted by TCNA, the ANSI accredited A108 standards committee voted to adopt the recommendation from Bönig's research for level interior spaces into the ANSI A137.1–2012 standard. Specifically, the standard sets a required minimum DCOF threshold of 0.42 for surfaces expected to be walked upon when wet, as measured according to Section 9.6. By requiring a value higher than 0.38, the standard provides an additional measure of safety over the previously widely-used ASTM C1028 wet SCOF value of 0.60 (per research at TCNA on 300 tile surfaces).[6]

After a 15-year wait, Dr. Bönig's work, and the work that preceded and followed, has borne fruit, not only in Germany, but also in the United States and potentially in many tile consuming countries of the world.

Notes

1. *TCNA Tile Initiative* 2013, Tile Council of North America; included in 2013 *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation,* and available separately from TCNA as a free download at www.tcnatile.com.
2. *TCNA Tile Initiative* 2012, Tile Council of North America; included in 2012 *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation,* and available separately from TCNA as a free download at www.tcnatile.com.
3. In the German Ramp test, developed by Skiba, Scheil, and Windhövel of the Bergische Universität Wuppertal, a trained evaluator, wearing standardized footwear, walks on a flooring sample evenly coated with oil. Starting with the ramp in a horizontal position, the evaluator increases the angle of the ramp until a slip occurs. The angle at which the slip occurred is used to express the degree of slip resistance per the table below.

Slip Resistance	Acceptance Angle
R9	From 6° to 10°
R10	From 10° to 19°
R11	From 19° to 27°
R12	From 27° to 35°
R13	Over 35°

4. In order to determine the force components from which the friction requirement can be calculated, multi-component force platforms ("force plates") were employed to measure forces perpendicular to the surface (Fz) and tensile and pressure forces in both tangential axes (Fy and Fx).
5. Dr. Bönig's work preceded the development of a standard for making in situ measurements, and he subsequently moved on to other areas of endeavor. He is recognized today as one of the world's leading designers of industrial fastener technology with over 20 patents to his credit. Further research by Sebald and others led to the development of standards for making field measurements (ANSI A137.1 and DIN 51131) allowing Bönig's research to be applied in all hard surface flooring applications.
6. While the 300 tiles chosen were selected to represent a wide spectrum of surfaces, no claim is made or offered that this represented the entire spectrum of available tile surfaces nor can any inference be made regarding any individual tile surface. ASTM C1028 SCOF measurements and DCOF measurements cannot be directly compared or correlated on a per-tile basis, as different sensors, test conditions, and measurement physics are employed.

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TCNA BULLETIN

COEFFICIENT OF FRICTION (COF) STANDARD FOR CERAMIC TILE

DON'T SLIP UP WHEN IT COMES TO SAFETY!

Be sure your tile specs are in accordance with the COF requirements of ANSI A137.1 including, "Unless otherwise specified, tiles suitable for level interior spaces expected to be walked upon when wet shall have a wet DCOF of 0.42 or greater," when tested per the DCOF AcuTest.®

The ANSI A137.1 standard for ceramic tiles also states, "The specifier shall determine tiles appropriate for specific project conditions, considering by way of example, but not in limitation, type of use, traffic, expected contaminants, expected maintenance, expected wear, and manufacturers' guidelines and recommendations."

If you're specifying, selling, manufacturing, installing, or maintaining ceramic tile floors, it's important to know about these 2012 changes to ANSI A137.1. Project plans and specifications, maintenance programs, etc., referencing only a static COF of 0.6 per ASTM C1028 (the old COF test method) do not meet the requirements of the current standard.

To meet the current DCOF AcuTest criteria, you cannot use COF values from C1028 measurements. The test methodologies are different, and accordingly, there is no direct correlation between specific C1028 COF values and the values measured by the DCOF AcuTest. Additionally, ASTM C1028 was withdrawn in 2014.

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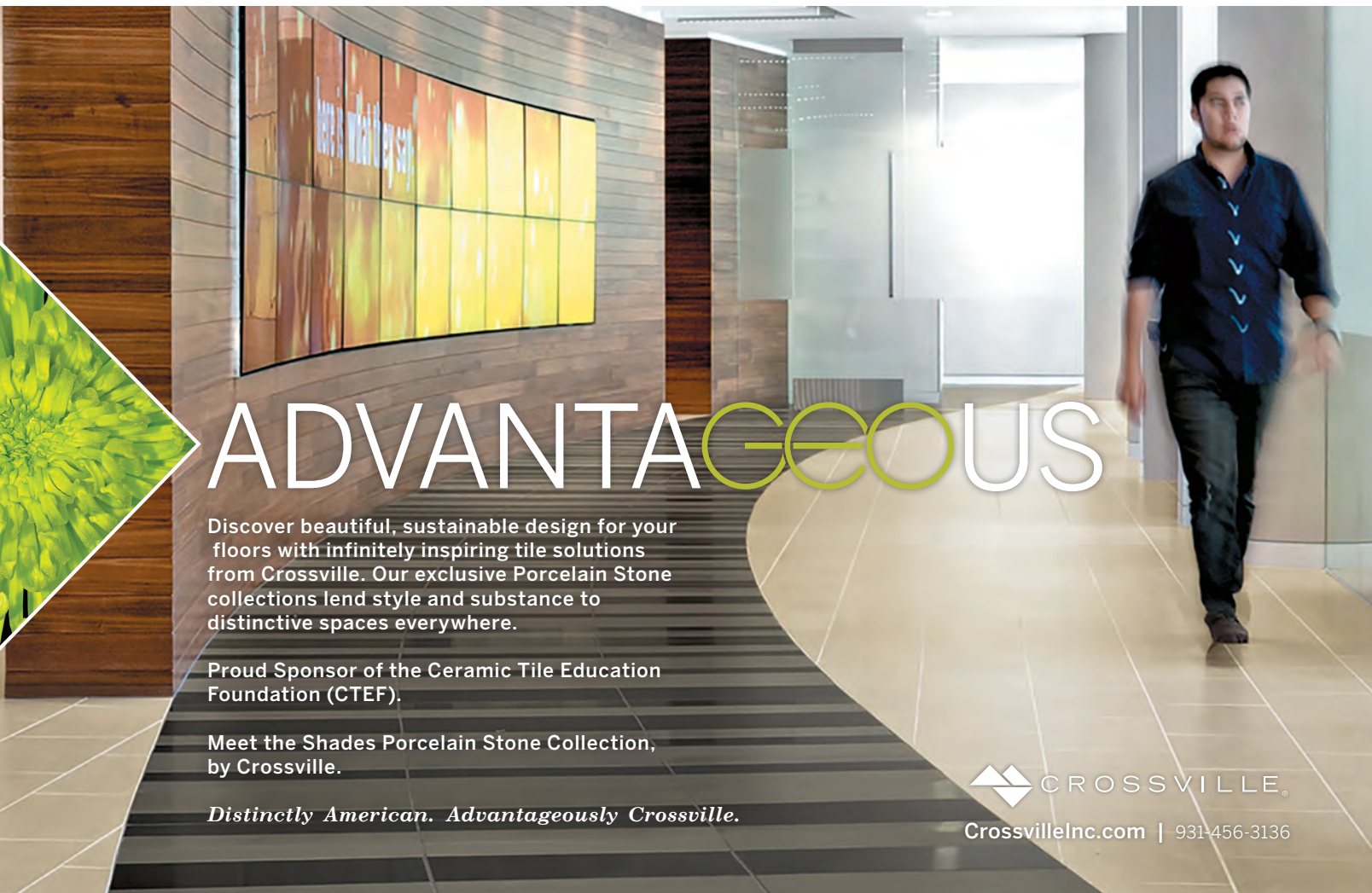

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HAZCOM REVISIONS
NEW LABELING AND SAFETY TRAINING REQUIREMENTS

New Product Labeling and Chemical Safety Training Requirements: GHS Compliance in OSHA's Current "HazCom" Standard

Tile installers, distributor warehouse staff, and others who handle tile installation materials may be noticing new hazard and safety labels on buckets and bags. This change reflects the 2015 decision by the U.S. Occupational Safety and Health Administration (OSHA) to revise the U.S. Hazard Communication Standard (HCS), commonly known as "HazCom," to be consistent with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). The GHS is a chemical labeling system developed over the course of more than a decade by a United Nations committee of international experts in diverse fields including chemicals, worker safety, and regulatory affairs. In the context of GHS, the word "chemical" refers broadly to all types of substances, products, and mixtures, including tile installation materials like mortars, grouts, sealers, mastics, and any other chemical-containing products.

Resulting from this action by OSHA, tile installation materials manufacturers must now label their chemical-containing products—those for use in the United States—according to new HazCom labeling requirements derived from the GHS or according to the labeling requirements of the Consumer Product Safety Commission (CPSC).

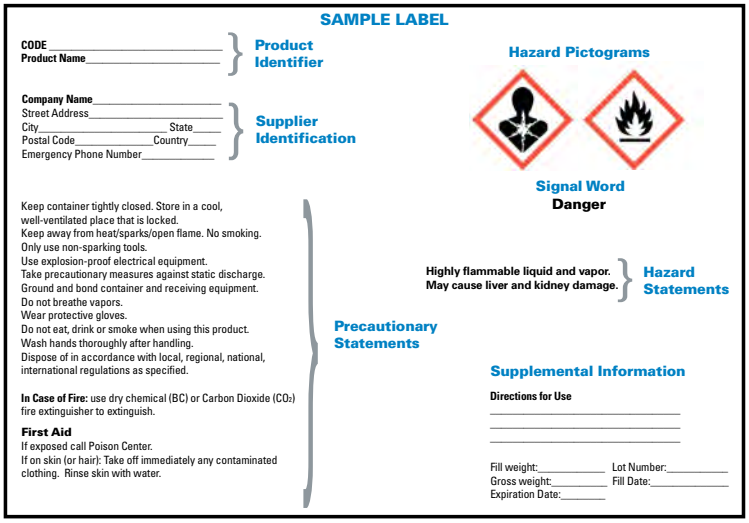
The determining factor is to whom the products are sold. Products sold to retail consumers, including through big box stores and the internet, as many tile installation materials are, fall under the regulatory standards of the Consumer Product Safety Act, and a CPSC-compliant label must be used. Conversely, products that are not sold at all to retail consumers (i.e. professional products) must incorporate the new GHS-based HazCom chemical warning labels on their packaging.

HazCom revisions also require employers of workers who handle chemical-containing products, including mortars and grouts, to implement a chemical hazard communication and safety training program for all products with GHS labels and most products with CPSC-compliant labels.

Products with GHS Labels

Whereas, according to OSHA, the 1985 HazCom Standard "allowed chemical manufacturers and importers to convey hazard information on labels and material safety data sheets in whatever format they chose," HazCom now provides specific criteria that manufacturers must use to determine hazards and classify chemical mixtures, as well as the exact words and images that must be used to communicate certain portions of that information, for products subject to HazCom labeling. Each chemical-containing product must bear a label that includes the requisite pictogram for the hazard, signal word(s), hazard statement(s), precautionary statement(s) such as proper material handling and first aid instructions, product identifier information, and supplier identification.

For these products, manufacturers are also now required to provide revised material safety data sheets (MSDSs), which are now to be called "safety data sheets," or SDSs. The new format for SDSs requires the inclusion of information in 16 categories, with some categories focused on human hazards like carcinogenicity, while others address environmental hazards such as aquatic toxicity.



In addition, for products subject to HazCom labeling, employers of workers handling those products must implement a chemical hazard communication program and related safety training. OSHA mandates that the program must incorporate information about the new labels on containers of chemical-containing products and the new SDSs for those products. And, employers must document how they will meet the new HazCom requirements in each of these areas.

Products with CPSC-Compliant Labels

For chemical-containing products that are sold to consumers (not exclusively to industry professionals) and therefore bear a CPSC-compliant label, the same training and SDS rules apply as for products with GHS labels. The only exception to this would be for the limited instances in which a consumer product is used in the workplace "where the employer can show that it is used in the workplace for the purpose intended by the chemical manufacturer or importer of the product, and the use results in a duration and frequency of exposure which is not greater than the range of exposures that could reasonably be experienced by consumers when used for the purpose intended," as given in the HazCom 2012 Final Rule (29 CFR 1910.1200 (b)(6)(ix)). Hand soap in the bathroom would be a common example.

Nevertheless, simply because a chemical-containing product is commonly used by consumers does not mean an SDS and worker training would not be required. For example, mineral spirits are sold to the public and are used by various construction trades. A training program related to mineral spirits and its potential hazards may not be required for a crew of tile installers who use it occasionally to touch up urethane caulk; but such a training program would be required for painters using it regularly to clean their brushes.

Compliance Deadlines

Manufacturers have changed their product packaging to conform to the new classification criteria and labeling requirements and have transitioned from providing MSDSs to SDSs in the new OSHA-specified format to meet OSHA's June 1, 2015 deadline for doing so. Shipment of products in the United States labeled under the old system has been disallowed by OSHA since December 1, 2015, a deadline that applies to any entity shipping a chemical-containing product, so it affects tile distributors, dealers, contractors, and others in the industry, not just manufacturers.

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Tile contractors, distributors, manufacturers, and other employers that must implement chemical hazard communication and safety programs are required to update their product safety information continuously as new SDSs are made available by manufacturers. By June 1, 2016, employers are required to update their workplace labeling and hazard communication programs (such as posted signage in warehouses and shops), and to provide the applicable employee training, including newly identified physical or health hazards resulting from the new labeling, according to OSHA.

Intended Benefits

The updated OSHA HazCom regulations are not specific to the tile industry. Rather, the products used in the tile industry are among the thousands of chemical-containing products and mixtures that are subject to the new requirements, and tile industry workers are among the 43 million workers that OSHA estimates are involved in producing or handling hazardous chemicals in more than five million workplaces across the country.

Altogether, the new HazCom requirements form a strategy to prevent chemical exposure and chemical-related injury to humans and the environment by heightening worker awareness of the presence of chemicals in the products they use, the hazards associated with those chemicals, and related precautions and first aid measures.

According to OSHA, implementation of specific and standardized criteria for classifying chemicals according to their hazards, coupled with standardized labeling and new SDS formatting will greatly improve worker safety by increasing worker awareness of chemicals associated with their jobs, especially for low and limited-literacy workers. “Behind every image are uniform organization and classification systems that spell out the potential hazards and protections in terms that everyone, worldwide, can understand, whether you are working with chemicals, manufacturing them, transporting them, or supervising employees exposed to them,” states Assistant Secretary of Labor David Michaels in a video on the OSHA website. The updated labeling “provides warnings that are clearer, necessary action more obvious, and protections readily apparent.”

Similar intentions are behind the migration away from MSDSs. By providing more complete, easier-to-understand hazard information, the new SDSs are intended to serve as a more useful resource for general purposes and as a safety training aid.

There are also possible economic and trade-related benefits associated with harmonizing chemical-related standards across agencies, industry sectors, and countries rather than maintaining numerous similar but independent regulations. "While the existing laws and regulations are similar, they are different enough to require multiple labels for the same product both within the U.S. and in international trade and to require multiple safety data sheets for the same product in international trade," OSHA states. Additionally, "several U.S. regulatory agencies and various countries have different requirements for hazard definitions as well as for information to be included on labels or material safety data sheets. For example, a product may be considered flammable or toxic by one agency or country, but not by another."

OSHA optimistically estimates "savings of $475.2 million from productivity improvements for health and safety managers and logistics personnel, $32.2 million during periodic updating of SDSs and labels, and $285.3 million from simplified hazard communication training," and another $250 million a year for reduced fatalities and injury/illness.

But for now and the next few years, the costs of implementation to the tile industry, and other affected industries, will be significant. OSHA identifies four major implementation costs: classifying chemical hazards in accordance with the GHS criteria and revising SDSs and labels to meet new format and content requirements, training for employees to become familiar with new warning symbols and the revised SDSs, management familiarization with the new GHS system and engagement in related

activities, and higher printing costs for required color printing of HazCom labels. The agency estimates costs of about $201 million a year to U.S. businesses for these types of expenses.

For More Information

The updated HazCom regulations are far-reaching and complex; companies should consult with legal or industry professionals for advice specific to their situation and consult the specific text of laws, statutes, and regulations relevant to the issues discussed herein. This article is not intended to provide legal advice, nor, due to its general informational nature, should it be relied upon as applying to any specific and factual situation.

To learn more about the labeling, SDSs, and safety training requirements, visit the OSHA website (www.osha.gov/dsg/hazcom/index.html), where several fact sheets and employer compliance guides are available, as well as links to the full text of HazCom and the GHS. For specific guidance on how OSHA compliance safety and health officers will enforce the 2012 HazCom standard during its transition period and when fully implemented, go to www.osha.gov/OshDoc/Directive_pdf/CPL_02-02-079.pdf.

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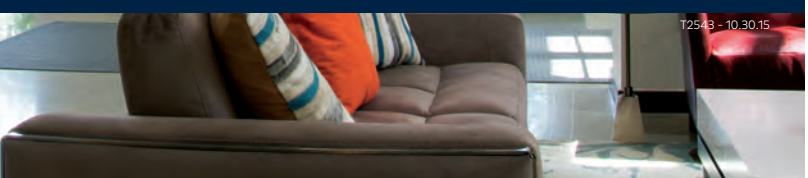

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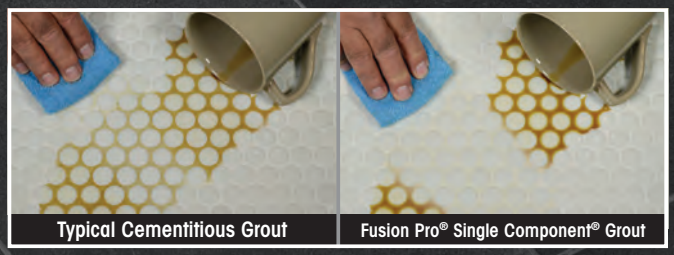

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BY floridatile

PORCELAIN TILE CERTIFICATION **AND THE PORCELAIN TILE CERTIFICATION AGENCY (PTCA)**

In 2008 Tile Council of North America (TCNA) partnered with the Ceramic Tile Distributors Association (CTDA) to create the Porcelain Tile Certification Agency (PTCA) to certify porcelain tile. This program was formed at the initiative of distributors and manufacturers who were concerned with the amount of tile being sold in the United States that was marked as porcelain but which was in fact not porcelain.

What is porcelain tile, and why does it matter whether a tile is porcelain?

As defined by the ANSI A137.1 ceramic tile standard, porcelain tile is a ceramic tile with a very low water absorption (0.5% or less), as tested per ASTM C373. Porcelain tile is denser and has a lower water absorption than other types of ceramic tile. When non-porcelain tiles are unknowingly substituted, freeze/thaw and expansion failures can result from unexpected moisture absorption.

Why was this porcelain tile certification program created?

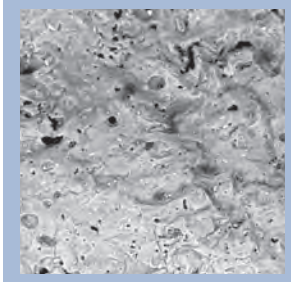
It is well known that some non-porcelain tiles made overseas are knowingly mislabeled as porcelain, with exporters and importers choosing to ignore the relevant North American standard (ANSI A137.1). While the criteria for porcelain tiles have been well-defined for several decades in North America, this practice of mislabeling tiles began when the term porcelain was undefined in international standards. Today the term is well defined, but the method used internationally for measuring water absorption is less rigorous than the ASTM C373 method used in North America.

Simply stated, this means that some tiles classified as porcelain overseas don't meet the stricter and more demanding water absorption criteria used in North America.

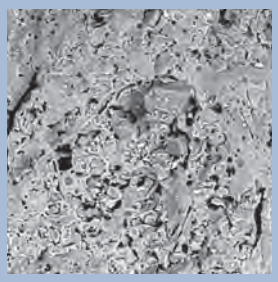
CERTIFIED PORCELAIN TILE
0.5% or less water absorption

A TCNA lab technician performs the water absorption test per ASTM C373.

Tile Porosity Magnified 200x



0.39% water absorption



5–6% water absorption

In freeze/thaw and wet environments, that can be important. Given that approximately 70% of the tiles sold in the United States are imported, PTCA certification was developed to protect the consumer from tiles either intentionally mislabeled or mislabeled due to differences in testing.

Through the PTCA program the need for porcelain certification has become even more evident, as 24% (305 tile series out of 1,274 total tested) failed, as of the third quarter of 2015.

Can only manufacturers sign up for PTCA certification?

No. The program is open to both manufacturers and sellers of porcelain tiles. Either can be a program participant.

PTCA certification: What does it mean?

Recognizing that the extent of this false labeling issue only applies to whether or not tiles meet the water absorption criteria of the ANSI A137.1 standard, PTCA certification was developed only to independently evaluate if the program participant understands North American water absorption criteria and can meet such. Tiles are not checked to see whether or not they meet all the other relevant properties for porcelain tiles in the ANSI A137.1 standard; variance from those properties has not been an issue in general, and the criteria are well understood. For each series being evaluated, five commercially available samples (selected by the participant) are sent once every three years by manufacturing participants and annually by non-manufacturing participants.

Passing the initial testing establishes that the participant understands and can meet North American water absorption criteria.

For more details on the PTCA program, the PTCA Program Participation Agreement is publicly available and can be found at www.ptcaonline.org/participantaspx#app.

PORCELAIN TILE CERTIFICATION **AND THE PORCELAIN TILE CERTIFICATION AGENCY (PTCA)**

If a box of tiles has the PTCA certification mark on it, is PTCA stating that those tiles meet ANSI A137.1 water absorption criteria?

No. PTCA establishes that the program participant understands North American water absorption criteria and is able to meet such. The quality of the tiles being sold is exclusively controlled by the actual manufacturer.

If a box of tiles has the PTCA certification mark on it, is the program participant stating that those tiles meet all ANSI A137.1 criteria?

While the program participant may independently claim compliance with all ANSI A137.1 porcelain tile criteria, that is not required by PTCA of program participants.

By participating in the PTCA certification program, the program participant (i.e., the manufacturer and/or seller) is stating that the tiles it produces or sells labeled with the PTCA mark meet the ANSI A137.1 porcelain tile water absorption requirements.

Non-manufacturing participants are further required to obtain a written assurance from the actual manufacturer that it will immediately notify the participant of any changes in the conforming porcelain tiles or any manufacturing variances that may affect the certification.

To further ensure the program's effectiveness, participants have agreed not to use the PTCA mark in any way misleading or confusing to buyers, including displaying the certification mark in a way that would imply non-certified products are certified. Participants also are not allowed to transfer use of the mark to any other person or entity.

As noted above, PTCA certification does not mean the tiles tested met all ANSI A137.1 or ISO 13006 criteria, which would require testing for other physical properties such as dimensions, warpage, breaking strength, etc. That assurance would need to come from the manufacturer or via a third-party lab.

If a box of tiles has the PTCA certification mark on it, can those tiles be used in freeze/thaw and wet environments without concern?

While the tiles may be perfectly appropriate for such use, the PTCA certification mark does not suggest that. The suitability of any tiles for specific applications requires an analysis of the project conditions by a qualified individual and proper installation. The certification mark does not assure fitness for any particular purpose.

What are the benefits of the PTCA program?

The PTCA program is designed to directly benefit consumers purchasing porcelain tiles and, indirectly, everyone involved in the supply chain.

Participants benefit by being able to independently confirm to customers that what they are producing or selling is truly porcelain, and by being able to differentiate their products from falsely labeled porcelain products. Producing porcelain tiles can be a more intensive and costly process than producing non-porcelain tiles, so certification is a good way for manufacturers and sellers to confirm that investment to the market.

For distributors PTCA certification helps differentiate real porcelain tiles from those that are falsely labeled as porcelain.

Who polices PTCA-certified tile?

The marketplace does. If a question arises about whether a tile sold as PTCA-certified truly meets the water absorption criteria for porcelain tiles, PTCA is authorized to acquire further samples and test such for compliance. The board of PTCA then reviews the available data and relevant actions taken by the program participant to decide whether to withdraw PTCA certification and use of the mark.

Anyone who suspects a non-porcelain tile is being sold as PTCA-certified is encouraged to notify PTCA at 630-942-6588 or at info@ptcaonline.org.

TCNA BULLETIN
WHAT IS TRUE PORCELAIN?

The difference between real and false porcelain cannot be detected by eye. ... Suppliers of falsely-labeled porcelain are defrauding the consumer and benefitting from the popularity and market value of genuine porcelain.

CERTIFIED PORCELAIN TILE
0.5% or less water absorption

Porcelain tile has become increasingly popular over the past decade. The American National Standard Specifications for Ceramic Tile (ANSI A137.1) require tile to have a water absorption of 0.5% or less, to be classified as porcelain, when tested per ASTM C373, the most stringent test for measuring water absorption.

Manufacturing tile that meets this standard—true porcelain—requires porcelain-grade clays and other unique raw materials, plus precision milling processes and kilns set to extremely high firing temperatures (2100°F to 2500°F). The required raw materials, energy, and manufacturing equipment needed to produce such low porosity, high density tile are why real porcelain is typically more expensive than non-porcelain tile.

The difference between real and false porcelain cannot be detected by eye—the only way to know is to have a laboratory verify the tile's water absorption is 0.5% or less. Through its lab, Tile Council has identified 305 series (out of 1,274 total tested) of falsely-labeled "porcelain" tiles with a water absorption well over 0.5%—sometimes as high as 3%.

Suppliers of falsely-labeled porcelain are defrauding the consumer and benefitting from the popularity and market value of genuine porcelain. This is particularly true for imported tile, and, considering that approximately 70 percent of the tile sold in the United States is imported, much of the "porcelain" being sold may be falsely labeled.

ASTM C373 Water Absorption Test

For ceramic tile, *water absorption* refers to the maximum amount of water that a tile can be made to absorb. In the lab test ASTM C373, water is forced into the deepest pores of the tile.

So, measuring water absorption can also be looked at as measuring available tile porosity—the more water that can be absorbed, the more porous (less dense) the tile.

STEP 1

Tile sample is dried in an oven to ensure accurate dry weight.

STEP 2

Dried tile sample is weighed using a digital scale accurate to 0.001 gram.

STEP 3

Water is forced into the tile sample by boiling and soaking it.

STEP 4

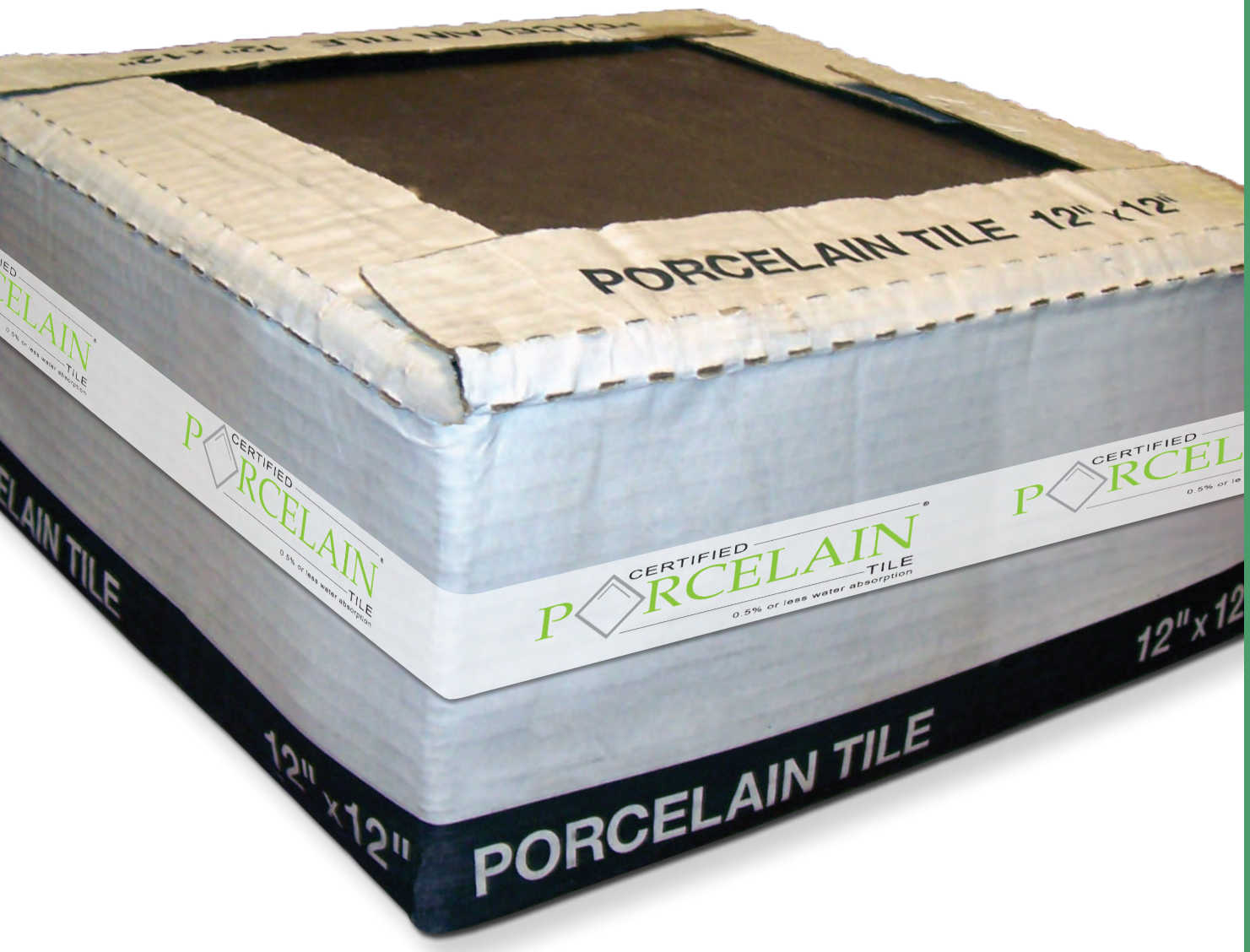
Saturated tile sample is weighed to determine amount of weight gain due to absorption of water.

STEP 5

Water absorption is calculated. The change in weight is expressed as the percentage of the tile's dry weight.

BE SURE

The Certified Porcelain Tile logo means the tile tested met the requirement of 0.5% or less water absorption for porcelain tile of the American National Standards Institute's A137.1 standard.



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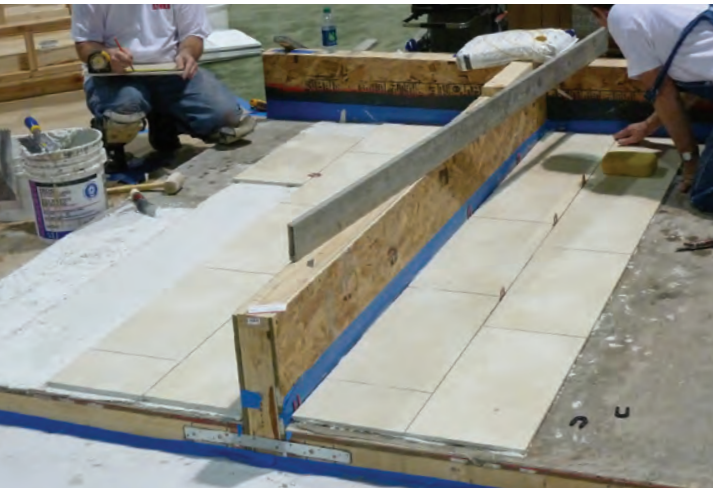
WHEN QUALITY IS THE BOTTOM LINE
MATCH ACT-CERTIFIED INSTALLERS TO THE JOB AT HAND

ACT
ADVANCED CERTIFICATIONS FOR TILE INSTALLERS

Tile setting has become a more and more specialized trade, yet it remains largely unregulated when it comes to requirements for installers, whether for training or for proven adherence to best practices and industry standards. The easy entry into tile setting means a contractor may have seasoned, skilled craftworkers or untrained installers with little experience under their belts. And, without an established skills baseline, the contractors that don't invest in installer training and education have a competitive edge, if the only consideration for choosing from a pool of tile contractors is which one has submitted the lowest bid, the norm for the vast majority of commercial work today.

This is the system for awarding tile jobs—too often to unqualified companies—that ACT (Advanced Certifications for Tile Installers) seeks to improve by establishing a skills baseline that allows consumers to compare costs and qualifications.

Launched in 2014, ACT is a program of written and hands-on testing for defined skill sets, like large format tile installation. While other training and certification programs are available to tile installers, ACT has garnered wide support from the tile industry because it is standards-based and highly demanding.



Construction and building design professionals are encouraged to integrate installer qualifications as requirements for bidding contractors, under "quality assurance" sections of their specs.

Requiring evidence of program completion or certifications under "submittals" is also recommended to help ensure the specified requirements for installers are met.

For ready-to-use boilerplate spec language, see the Installer and Contractor Qualifications Guide in the 2016* TCNA Handbook, *or, for easy copy and paste, visit www.tcnatile.com.

ACT tests are not show-up-for-a-demonstration-and-get-your-certificate events. A percentage of installers fail, which differentiates ACT as a meaningful certification, not an educational session. The tests have strictly enforced time limits, and installers' hands-on work is evaluated and scored in-person, by approved evaluators only. Upon completion of the hands-on component by the installer, the evaluator literally tears it apart. By prying up tiles and probing fresh mortar beds, ACT evaluators judge what's below the surface, a crucial component of the program, as so much of what is required for a successful tile installation lies below the finished tile work.

ACT tests are administered by the Ceramic Tile Education Foundation (CTEF) and the International Masonry Institute (IMI), which collaborated to develop the program, with support from product manufacturers and industry organizations including the National Tile Contractors Association (NTCA), Tile Contractors Association of America (TCAA), Tile Council of North America (TCNA), and the International Union of Bricklayers and Allied Craftworkers (IUBAC).

ACT Certification: GROUTS

Specify ACT GROUTS certification on every job where cementitious grout, epoxy grout, or modified epoxy emulsion grout will be used.

Critical Installation Skills Tested: Proper mixing, installation, and curing of cementitious grout, epoxy grout, and modified epoxy emulsion grout.

ACT Certification: LARGE FORMAT TILE / SUBSTRATE PREP

Specify ACT LARGE FORMAT TILE certification when tile larger than 15" long will be installed by a thin-bed method.

Critical Installation Skills Tested: Flattening a substrate to receive large tile and installing large tile within industry tolerances for coverage, flatness, and lippage

ACT Certification: MEMBRANES

Specify ACT MEMBRANES certification when a sheet or liquid membrane will be used for waterproofing or crack isolation.

Critical Installation Skills Tested: Application of sheet and liquid membranes with emphasis on avoiding installation errors that affect waterproofness

ACT Certification: SHOWERS

Specify ACT SHOWERS certification when designing showers with a mortar bed and tile floor over a shower-pan membrane.

Critical Installation Skills Tested: Creating a watertight (leak-proof) shower base that effectively evacuates water

ACT Certification: MUD WALLS

Specify ACT MUD WALLS certification when a mortar bed has been selected as the substrate for tiling walls.

Critical Installation Skills Tested: Installing wall mud to ANSI standards, with emphasis on proper materials and precision of finished work (flat, plumb, level, square)

ACT Certification: MUD FLOORS

Specify ACT MUD FLOORS certification when a mortar bed has been selected as the substrate for tiling floors.

Critical Installation Skills Tested: Installing floor mud to ANSI standards, with emphasis on proper materials and precision of finished work (flat, level)

CONGRATULATIONS
ACT-CERTIFIED INSTALLERS!

Tile Council of North America congratulates the tile installers who have demonstrated their exemplary knowledge and skills in the trade, a commitment to quality, and a passion for excellence.

ACT ADVANCED CERTIFICATIONS FOR TILE INSTALLERS GROUTS

New in 2015!

Greenwood, Sam
Requa, Jason

ACT ADVANCED CERTIFICATIONS FOR TILE INSTALLERS LARGE FORMAT TILE

Baker, Shawn R.
Baldacci, Peter H.
Becker, Ronald W.
Beliger, Michael
Bernal, Andres
Bugo, Fabio
Cardiff, Brian A.
Carr, James
Cass, Frank
Collier, Gavin D.
Compton, Darin
Creek, Clinton T.
Deel, Jason
DeSalvo, Victor
Dumas, William
Duschinsky, Paul A.
Edwards III, Robert
Felleisen, Paul
Fernandez, Michael F.
Freitas, Todd
Gajweski, Shaun
Gardner, Jacob M.
Gwizdala, Mike
Herron, Scott
Higgins, William J.
Kennedy, Jason M.
Lamcaj, Florenc
Lomeli, Alejandro
Lopez, Rafael
Maiuri, Philip A.
Manzarolli, Eric
McAdam, Wayne R.
Meyer, Raymond F.
Miller, Michael J.
Mion, Robert
Monroe, Brent
Nequist, Tyler
Norris, Jason
Novak, Sandra
Ornellas, Jeffrey S.
Ortiz, Jose G.
Pacetti, Dennis J.
Pair, Joshua
Panak, Robert A.
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Pugliano, Joseph
Ramos, Jorge L.
Rush, Jeff
Schaerer, Grant E.
Schoewe, Bryan J.
Sigley, Tommy L.
Sotelo, Peter Pio
Tavshanjian, Keith
Tetreault, Eric
Trame, Terrence K.
Tucker, William G.
Warner, Jerome D.
Welch, Dan
Yeo, John P.

ACT ADVANCED CERTIFICATIONS FOR TILE INSTALLERS MEMBRANES

Baker, Shawn R.
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Bugo, Fabio
Cardiff, Brian A.
Collier, Gavin D.
Compton, Darin
Cortez, Gabriel
Creek, Clinton T.
Deason, Brian
Deel, Jason
DeSalvo, Victor
Dumas, William
Duschinsky, Paul A.
Edwards III, Robert
Escamilia, Leonardo
Fernandez, Michael F.
Fleming, Randy
Freitas, Todd
Gajewski, Shaun
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Hellums, Dorsie
Herron, Scott
Higgins, William J.
Kennedy, Jason M.
Lomeli, Alejandro
Maiuri, Philip A.
Manzarolli, Eric
McAdam, Wayne R.
Meyer, Raymond F.
Miller, Michael J.
Mion, Robert
Monroe, Brent
Nequist, Tyler
Norris, Jason
Novak, Sandra
Ornellas, Jeffrey S.
Ortiz, Jose G.
Pacetti, Dennis J.
Panak, Robert A.
Pistor, Aaron
Porter, John
Pugliano, Joseph
Ramos, Jorge L.
Rush, Jeffery W.
Sauceda, Juan
Schaerer, Grant E.
Schoewe, Bryan J.
Sotelo, Peter Pio
Tavshanjian, Keith
Tetreault, Eric
Trame, Terrence K.
Tucker, William G.
Warner, Jerome D.
Welch, Dan
Yeo, John P.
Zhong, Zhong Mei

ACT
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SHOWERS

Becker, Ronald W.
Beliger, Michael
Bernal, Andres
Collier, Gavin D.
Costa, Alan R.
Creek, Clinton T.
Deel, Jason
DeSalvo, Victor
Dumas, William
Duschinsky, Paul A.
Edwards III, Robert
Fernandez, Michael F.
Fleming, Randy
Gajewski, Shaun
Galliani, Rich
Gardner, Jacob M.
Gwizdala, Mike
Hellums, Dorsie
Herron, Scott
Higgins, William J.
Kennedy, Jason M.
Lomeli, Alejandro
Maiuri, Philip A.
Manzarolli, Eric
Meyer, Raymond F.
Miller, Michael J.
Mion, Robert
Monroe, Brent
Nequist, Tyler
Ornellas, Jeffrey S.
Ortiz, Jose G.
Pacetti, Dennis J.
Pair, Joshua
Panak, Robert A.
Porter, John
Presny, Kevin
Pugliano, Joseph
Ramos, Jorge L.
Sauceda, Juan
Schaerer, Grant E.
Schoewe, Bryan J.
Sotelo, Peter Pio
Tavshanjian, Keith
Tetreault, Eric
Trame, Terrence K.
Tucker, William G.
Warner, Jerome D.
Welch, Dan
Yeo, John P.

ACT
ADVANCED CERTIFICATIONS FOR TILE INSTALLERS
MUD WALLS

Collier, Gavin D.
Compton, Darin
Cortez, Garbriel
Deason, Brian
Deel, Jason
Dumas, William
Duschinsky, Paul A.
Edwards III, Robert
Fleming, Randy
Freitas, Todd
Galliani, Rich
Hellums, Dorsie
Lomeli, Alejandro
Manzarolli, Eric
Meyer, Raymond F.
Miller, Michael J.
Mion, Robert
Monroe, Brent
Nequist, Tyler
Ortiz, Jose G.
Panak, Robert A.
Presny, Kevin
Pugliano, Joseph
Ramos, Jorge L.
Rush, Jeffery W.
Schaerer, Grant E.
Schoewe, Bryan J.
Tavshanjian, Keith
Tetreault, Eric
Trame, Terrence K.
Warner, Jerome D.
Welch, Dan

ACT
ADVANCED CERTIFICATIONS FOR TILE INSTALLERS
MUD FLOORS

Ballard, Jason
Becker, Ronald W.
Beliger, Michael
Bernal, Andres
Blaschchishchin, Vladimir
Bugo, Fabio
Collier, Gavin D.
Compton, Darin
Cortez, Garbriel
Costa, Alan R
Creek, Clinton T.
Deason, Brian
Deel, Jason
DeSalvo, Victor
Dumas, William
Duschinsky, Paul A.
Edwards III, Robert
Escamilia, Leonardo
Fernandez, Michael F.
Fleming, Randy
Gajewski, Shaun
Gardner, Jacob M.
Hale, Brad J.
Hellums, Dorsie
Herron, Scott
Higgins, William J.
Kennedy, Jason M.
Lomeli, Alejandro
Maiuri, Philip A.
Manzarolli, Eric
McAdam, Wayne R.
Meyer, Raymond F.
Miller, Michael J.
Mion, Robert
Monroe, Brent
Nequist, Tyler
Norris, Jason
Ornellas, Jeffrey S.
Ortiz, Jose G.
Pacetti, Dennis J.
Pair, Joshua
Panak, Robert A.
Pistor, Aaron
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Presny, Kevin
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Rush, Jeffery W.
Schaerer, Grant E.
Schoewe, Bryan J.
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TCNA BULLETIN
CHOOSING YOUR TILE CONTRACTOR

TILE: It's the go-to finish when you're looking for high fashion and high function. But you might not get either if you leave it to just anyone to install. Unlike plumbing, electrical, and structural masonry trades, tile installers and the tile contractors that employ them are not generally required to meet minimum trade craft criteria to be in business.

The difference between trained, experienced installers and inexperienced installers is noticeably reflected in their work, and the difference between a quality contractor and a deficient one is reflected in their service and business operations.

Together, contractor and installer transform your concept into reality. Whether you're a design/build professional selecting tile contractors on a regular basis or a homeowner with a single tile project, it's just not possible to overestimate the importance of finding qualified contractors and installers.

The Reputable Tile Contractor

- ☑ **Operates a legitimate business**, with responsible business practices and a policy of standing behind their work.
- ☑ **Invests in continuing education** necessary to stay up-to-date on current building codes, regulations, standards, and best practices. On-the-job training is the most popular way to learn a construction trade, but formalized training is a must for ensuring correct installation methods are being taught to and used by installers on your project.
- ☑ **Carries all required business licenses and insurances**, and doesn't push liabilities for property damages or worker injuries onto others.
- ☑ **Does not misclassify workers** to avoid paying into social security, unemployment, workers' compensation, and other employee programs.
- ☑ **Has a traceable business location** so customers can be sure post-installation questions and issues are addressed and resolved.
- ☑ **Has a track record for quality and service:** Good contractors can easily produce references and verifiable documentation of their commitment to quality and service.

Architects & Specifiers

Include language in job specifications requiring qualified labor and enforce it with the GC. See the *TCNA Handbook* for a list of industry recognized prequalification programs for installers and contractors such as the CTEF Certified Tile Installer Program, the ACT (Advanced Certifications for Tile Installers) Program, the NTCA 5-Star Contractor Program, and the TCAA Trowel of Excellence Program.

General Contractors

Deliver a quality tile installation by fulfilling contractor qualification requirements in job specifications. When not included, utilize internally developed qualifications. Require proof of qualifications to be included with all project bids. Thoroughly compare estimates from bidding contractors before awarding contracts. Often, higher estimates reflect better materials and additional necessary components and tasks, like substrate preparation and movement joints.

Homeowners

Don't hesitate to ask contractors for proof of insurance, their license (where required), and their installation qualifications. Thoroughly interview bidding contractors and check several references. Utilize consumer resources available from your state on the internet and from the Ceramic Tile Education Foundation.

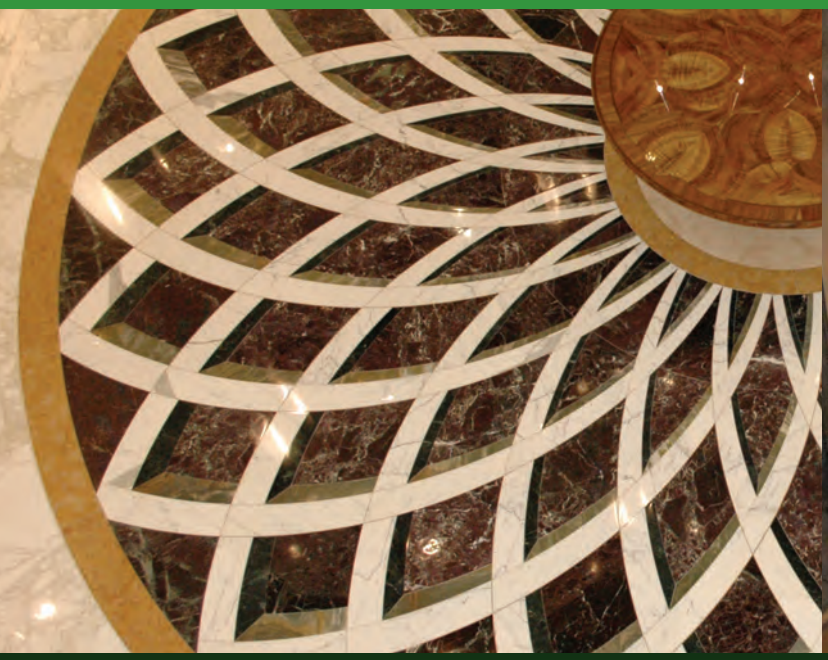
"Because tile is a permanent finish, the lowest bid should not be the driving factor, but rather who is the most qualified to perform the scope of the work specified."

— TCNA Handbook

Call CTEF at 864-222-2131 or visit tilecareer.com for assistance finding or specifying a quality contractor.

NTCA Five-Star Contractors and TCAA Trowel of Excellence Contractors

are uniquely qualified to provide the craftsmanship and service you deserve.



The Tile Council of North America Handbook strongly recommends using installers who have demonstrated their commitment to their craft.

Because tile is a permanent finish, the lowest bid should not be the driving factor, but rather who is the most qualified to perform the scope of the work specified.

TCAA Trowel of Excellence and NTCA Five Star Contractors have a proven track record of success for both residential and commercial installations. These companies have demonstrated their commitment to professionalism by passing rigorous review of their training, management and safety practices and enjoy strong support from peers, customers and suppliers.

Contact the NTCA and TCAA for qualified Five Star and Trowel of Excellence contractors for your upcoming project.

www.tile-assn.com/Member/FiveStar.aspx?mid=84
www.tcaainc.org/trowel-of-excellence.php

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