NFBA’s newest post-frame construction tolerances document

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All building components are assumed to have specific dimensions, and the locations of the components are dimensioned on drawings to a theoretically exact position either relative to each other or relative to one or more datum points. In reality, all component dimensions and positions vary somewhat. The acceptable amount of this variation is the tolerance of the component dimension or installed position.

In 1999 the National Frame Builders Association published a document entitled “Accepted Practice for Post-Frame Building Construction: Framing Tolerances.” This document, which is available for purchase from the NFBA (www.nfba.org), contains recommended tolerances for the position/placement of footings, posts, trusses, girders, girts, and purlins. NFBA members may download the document free of charge from the NFBA Web site.

During the 2005 Frame Building Expo in Columbus, I spoke about the development of an NFBA document entitled “Accepted Practices for Post-Frame Building Construction: Metal Panel and Trim Installation Tolerances.” This document, which is now complete, contains recommended tolerances for metal panel positioning, metal trim positioning, fasteners installation, and surface and edge blemishes.

Like its predecessor, the new construction tolerances document does not list reasons for its development, nor does it detail the process or any of the research involved in its development. Consequently, this article will focus on reasons behind document development (Bohnhoff, 1999), as well as the developmental process. This discussion will be followed by a brief overview of document contents.

Why a Construction Tolerances Document?

Numerous construction tolerance documents have been developed by organizations and associations throughout the country. This includes documents for framing elements in concrete-, steel-, and wood-frame buildings, as well as documents applicable to siding and flooring systems, roofing materials, insulation, windows and doors, interior finishes, and numerous other components and systems. Although the contents of these documents may differ, virtually all have been developed for the same reasons, which include the need to: (1) establish standards of professional conduct, (2) enhance professional reputation, (3) minimize costly litigation, and (4) maintain regulatory control within the profession.

Establishing Standards of Professional Conduct

Since its inception in 1971, a primary purpose of NFBA has been “to emphasize the importance of achieving and maintaining the highest standards of professional conduct within the industry, to the end that continuing consumer faith and trust in NFBA members is perpetuated” (NFBA Constitution, Article III, Section 1(5), 2005a). To promote this constitutional purpose, NFBA developed a code of ethics under the title Standards of Professional Conduct for Members of the National Frame Builders Association (NFBA, 2005b). This code of ethics contains seven canons, including the following two.

● Each NFBA member shall abide by present and future standards of the NFBA.

● Each NFBA member shall promote professionalism within the Industry and shall work diligently to establish and perpetuate consumer faith and trust in the NFBA.

The task of developing and updating NFBA building standards is the responsibility of the NFBA Technical and Research Committee. This long-standing committee, which was originally called the Recommended Practices Committee (Frame Building Professional, February 1989, page 29), was renamed the Education and Research Committee before receiving its current designation as the T&R Committee. Major documents that the committee has developed to date include NFBA’s “Recommended Practices for the Design and Construction of Commercial and Agricultural Post-Frame Buildings,” the “Post-Frame Building Design Manual,” and the aforementioned “Accepted Practice for Post-Frame Building Construction: Framing Tolerances.” Simply stated, the mission of the NFBA T&R committee is to help ensure a level of construction quality that will perpetuate consumer faith and trust in NFBA.

Quality construction work is assumed and/or expected by two groups of people: consumers who have never been involved in construction, and builders who pride themselves on the quality of their work. In between these two groups are builders with little or no experience — individuals who may lack the necessary skills and knowledge to consistently produce a high quality product. It is these builders who can benefit most from documents produced by the NFBA T&R Committee.
Like all other types of construction, there are procedures unique to post-frame construction that, when learned, not only enhance quality but also speed construction and provide a safer working environment. This includes procedures that detail, for example, what dimensions are critical to hold at each phase of construction, where and when bracing should be installed, when temporary bracing can be removed, where temporary connections should be used, when permanent connections should be made, etc.

Following established construction procedures is, by itself, no guarantee of quality construction. Such quality requires a certain degree of individual skill as well as a commitment to quality. To quickly and accurately assess construction quality generally requires reference to a written standard, that is, a set of construction tolerances. Unfortunately, prior to this year, no construction tolerances existed for the installation of metal paneling and trim. Consequently, there was no quick and easy way for a builder to gauge the quality of their finish work, or that of others.

Because they can be used to differentiate quality construction from poorer construction, construction tolerance documents are used at several different levels to establish standards of professional conduct. At the highest level, they are used to evaluate companies for inclusion or exclusion from an association. At an intermediate level, they are used by building manufacturers to establish standards for those erecting their buildings. At the lowest level, they are used by contractors to reassure clients. This occurs when a contractor includes a construction tolerances document either directly or by reference in a contract. As a guarantee of quality, a construction tolerance document reduces a client’s anxiety upon the purchase of a new building.

Enhancing the Reputation of a Profession

At a local level, the reputation of a company determines how other companies, governmental agencies, and consumers interact with the company. A firm that has a reputation of unethical practices will, in time, lose the support of subcontractors and suppliers and will be subjected to increased scrutiny by building inspectors and other regulatory enforcement agencies. In addition, the firm can expect to lose repeat customers and add fewer new clients.

The reputation of an association is defined by the reputation of its members. When comprised of builders of integrity that are committed to quality, the reputation of the association is significantly enhanced to the benefit of the entire industry. NFBA was founded as an organization of builders who voluntarily agreed to adhere to the highest ideals of honesty, courtesy, and integrity, and to evidence these ideals in the conduct of their business. The end result has been recognition and acceptance of post-frame buildings at a level greater than envisioned when the organization was originally founded. This reputation will continue to benefit all post-frame builders as they work with state and local code officials and planning commissions.

Minimizing Costly Litigation

Construction tolerance documents help define what is and what is not acceptable. In the absence of such documents, differences that could be resolved after brief mediation, end up in arbitration, and even more costly and time-consuming litigation.

Since most clients are familiar with their contractor prior to entering into contract, one would expect that most clients’ expectations are met or exceeded by their contractors. On the other hand, since no contractor truly knows the expectations of each client, disagreements are bound to arise sooner or later. When you, as a contractor, feel you’ve done your best, but your best isn’t good enough for your client, what are your alternatives? What do you tell your client? What industry standards do manufacturers establish for those erecting their buildings. At the lowest level, they are used by contractors to reassure clients. This occurs when a contractor includes a construction tolerances document either directly or by reference in a contract. As a guarantee of quality, a construction tolerance document reduces a client’s anxiety upon the purchase of a new building.

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you have to support your position?

Every profession must deal with clients who refuse to pay for services rendered no matter the quality of service. In the case of construction, many of these clients are hoping that their contractor will simply walk away from the project because the cost for them to collect what’s owed is likely to exceed what they are actually owed. When these delinquent clients are called on the carpet, some will produce an extensive list of concerns, of which the vast majority may be non-existent problems.

Regardless of whether the problems are real or imagined, they must each be addressed. In the absence of applicable standards, the cost and time to address each problem can increase substantially, and the entire process becomes more frustrating and stressful.

The need to minimize costly litigation was a major goal of the founders of NFBA. One of the original standing NFBA committees was the Arbitration Committee whose responsibility was to formulate and disseminate information on arbitration procedures for voluntary use of the NFBA membership in handling problems as they may arise between member companies and their clients” (FBP, February 1989, page 29). This committee was chaired by Freemon D. Borkholder, the Indiana builder responsible for organizing the meeting that resulted in the formation of the NFBA. Freemon also was involved in the development of a document entitled “Indiana Chapter NFBA: Approved Standards 1981.” This document, which was introduced at the 1981 annual meeting of the Indiana Chapter of
NFBA, included common building defects and problems, acceptable tolerances on these defects, and builder repair responsibilities for each specific defect/problem. The primary purpose of the document was to enable arbitrators and experts to (1) follow a pattern of consistency and/or (2) provide assistance in determining if proper materials were utilized in construction. Despite the fact that it was developed for use in Indiana, the document appealed to NFBA members in other states. Although some of these members openly discussed its modification for use nationally, the document was never rewritten for a broader jurisdiction.

**Maintaining Regulatory Control Within The Profession**

The original formation of NFBA can be attributed to an explosion during construction of the Coliseum at the Indianapolis fairground. This explosion led the Indiana Legislature to take a closer look at the state’s building codes, and consider adoption of either the BOCA or Uniform Building Code. Since adoption of either code would have required all wood frame commercial buildings to have a continuous concrete foundation, it would have had a negative impact on the post-frame building industry. This led Freemon Borkholder to organize a meeting of post-frame builders operating within the state. Approximately 20 builders attended the meeting that led to the formation of the NFBA. As one of its first major actions, the association hired an architect named Merrill T. Jones to draft new specifications on post-frame construction for commercial buildings. Jones’ specifications, which were submitted to, and subsequently adopted by the Administrative Building Council of the State of Indiana, helped legitimize the post-frame building in the eyes of Indiana’s code officials.

The circumstance behind the founding of NFBA points out the advantage of organization in addressing regulatory issues. No single builder has the time and resources to adequately address every issue critical to their business. However, when individual builders are properly organized to address problems, many critical issues can be addressed with just a small contribution from each builder. There is little doubt that the concerns of a person who represents a thousand other people carries considerably more weight than the concerns of a person who speaks only for himself/herself.

Potential code issues are most effectively addressed before they become major issues. This more proactive approach generally involves the development of consensus documents within the organization. By developing its own documents, an association of builders has more control over the codes, regulations, and other specifications that govern its industry. In addition, through such self-regulation, an industry invites less outside regulation and control.

Most trade associations and organizations develop construction tolerance documents for individuals who are not part of the association or organization. Specifically, the documents are intended for use by architects, engineers, and building designers who write the building specifications and assemble the contract documents that dictate how association members must perform their work.

**How Was the Document Developed?**

**Formulating An Approach**

At the March 4, 1999 meeting of the NFBA Technical and Research Committee, it was proposed that NFBA move forward with the development of a second construction tolerances document; one that covered metal trim and corrugated panel installation. As with the framing tolerance document, it was apparent that development of the new document could not begin until fundamental research was conducted; in this case, research that would determine just how accurately metal panels and trim were installed on the typical post-frame building.

Funding for field research was subsequently approved by the NFBA Board, with the University of Wisconsin-Madison agreeing to conduct the research. At its October 30, 2002, meeting, the NFBA T&R committee discussed specific information to be collected by the UW-Madison researchers.

**Field Research**

Working under my direction, UW-Madison graduate student David Cockrum (Figure 1) began a “quality assessment” of light-gauge metal cladding and trim installation during May...
2003. This work was completed during June 2004. Fifty-two buildings located in southern Wisconsin were investigated, representing the work of seven different independent companies. Note that the scope of this study was limited to buildings in southern Wisconsin to limit transportation costs.

Nineteen of the surveyed buildings were designed for an agricultural related end-use, 15 were constructed for commercial/industrial use, and 18 were residential-related buildings. Maximum, minimum, and average widths of the surveyed buildings were 104 feet, 24 feet, and 47.7 feet, respectively. Maximum, minimum, and average building lengths were 400 feet, 27 feet, and 85.9 feet, respectively. Maximum, minimum, and average eave heights were 22 feet, 8.3 feet, and 13.8 feet, respectively. Finally, maximum, minimum, and average floor areas were 32,000 feet², 650 feet², and 4,660 feet², respectively. Approximately 80 percent of the buildings were less than a year old when surveyed.

The following 18 items were assessed at the building sites: wall panel plumb, wall panel-to-roof panel alignment, corner trim squareness, corner trim-to-wall panel alignment, upper panel-to-wainscot alignment, roof panel end offset, roof panel overhang, wall panel base-to-trim spacing, wall panel end offset, horizontal alignment of wall fasteners, wall fastener drive depth, wall fastener drive angle, roof fasteners missing framing, irregular fastener patterns, scratches, scuffs and scrapes, dings/dents, and crimps/kinks.

Most measurements were made from the ground or from ladders. Some data was collected from a scaffold plank supported by ladder jacks. Roof surface characteristics were not assessed for two reasons. First, items not within normal view from the ground (e.g., roof fastener alignment) are typically not a subject of discussion or contention between builders and owners. Second, the cost to provide an OSHA-approved fall protection system for roof access at each building site — a system that would not permanently mark/alter the building — was beyond the project budget.

Field data was analyzed during June and July 2004, and summarized in an ASAE paper presented at the 2004 ASAE Annual International Meeting in Ottawa, Canada (Bohnhoff and Cockrum, 2004). In addition to containing a compilation of data, this paper details measurement methods and quantifies the accuracy of the methods.

### Drafting A Document

During the fall of 2004, I wrote the initial draft of a document entitled “Accepted Practices for Post-Frame Building Construction: Metal Panel and Trim Installation Tolerances.” I modified this draft following a line-by-line review by the NFBA T&R committee on December 2, 2004. Major adjustments included the addition of two appendices; one on galvanic corrosion, and the

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<th>Zinc (Galvanized)</th>
<th>Aluminum-Zinc Alloy (Galvalume)</th>
<th>Aluminum</th>
<th>Copper</th>
<th>Stainless Steel</th>
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<tr>
<td>Zinc Capped Screws***</td>
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<tr>
<td>Aluminum</td>
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<tr>
<td>Stainless Steel</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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</tr>
</tbody>
</table>

*Screws with an electrodeposited coating of zinc applied in accordance with ASTM B633.

**Nails with a zinc coating that meets or exceed ASTM A153 Class D thickness specifications.

***ASTM B633 electroplated screws with a special zinc or zinc-aluminum alloy cap.

Table C.2: Common Fastener Recommendations from Manufacturers
What Does the Document Contain?

Overview

Like the framing tolerances document, the new construction tolerances document is written using the general format prescribed by the International Organization for Standardization. The first three sections contain: the Purpose and Scope, Normative References, and Definitions, respectively. This is followed by the meat of the document, Sections 4 through 7, which cover: panel positioning, trim positioning, fasteners installation, and surface and edge blemishes, respectively. Section 7 is followed by the Commentary which contains a detailed explanation of each section's contents. The Commentary is followed by four appendices and a reference list. Following is a brief description of each of the document's major sections and its appendices.

Section 1: Purpose and Scope

The purpose and scope addresses the applicability of the document. It specifically states that the document only applies to installation of exterior metal panel and exterior metal trim with a nominal base metal thickness less than 0.05 inches (~18-gauge steel), and to exposed (aka through-panel) fasteners. This section also requires that measurements taken for assessment of construction quality be made prior to building use/occupancy or within 90 days of substantial building completion, whichever comes first. This clause is included because the greater the elapsed time between construction and field assessment, the more difficult it is to separate deviations and damage associated with normal structural use and aging from those associated with initial component placement.

Section 2: Normative References

The provisions of any documents listed as a normative reference become provisions of the document in which they are so listed. The new construction tolerance document lists only one normative reference and that is the “NFBA Accepted Practices for Post-Frame Building Construction: Framing Tolerances”
document (aka the framing tolerances document). This document was established as a normative reference because it helps define post-frame building terminology, influences post-frame building component selection, and contains tolerances appropriate to post-frame building construction. If provisions established in the framing tolerances document are not met, it becomes exceedingly difficult for builders to meet panel and trim installation requirements.

Section 3: Definitions

Section 3 contains 114 definitions associated with fabrication, installation, and durability of metal panels and trim. Definitions for scratch (shallow and deep), scuff, scuff area, scrape, and scrape area are unique to the document and essential to its application. In general, a scratch is a surface blemish caused by a single sharp point. Scuffs and scrapes are surface blemishes resulting from another surface or edge being drawn over the surface.

Unlike deep scratches and scrapes, shallow scratches and scuffs do not reveal underlying metallic coating and/or base metal. To qualify as a shallow scratch or scuff, the blemish must be visible by a majority of normal-sighted individuals when viewed under natural noonday lighting from an at-grade position no closer than 15 feet to the blemish in question. In practice, this requires that a line be drawn all the way around the building 15 feet from each exterior wall surface. If a majority of normal-sighted individuals spot the blemish on their own (i.e., without assistance from others) without ever entering inside the 15-foot offset boundary, then the blemish meets the visibility criteria.

Three other surface blemishes that have been categorized, uniquely titled, and defined in this document are edge kink, rib kink, and edge kink. Edge kinking is a permanent waviness in the overlapping edge of a corrugated panel. An edge kink is a permanent crease in the overlapping edge of a corrugated panel, which is specifically located between the edge and the first panel bend in from the edge. An edge kink is a permanent crease in the overlapping edge of a corrugated panel, which is specifically located between the edge and the first panel bend in from the edge. An edge kink is a permanent crease in the overlapping edge of a corrugated panel, which is specifically located between the edge and the first panel bend in from the edge. An edge kink is a permanent crease in the overlapping edge of a corrugated panel, which is specifically located between the edge and the first panel bend in from the edge.

Figures 2 and 3 show edge kinks and rib kinks, respectively.

Section 4: Metal Panel Positioning

Included in this section are tolerances for plumbness of individual wall panels, plumbness of adjacent wall panels, panel fanning, end-to-end alignment of wall panels, end offset of adjacent panels (sawtooth), panel edge-to-trim spacing, panel end-to-trim spacing, and roof panel overhang. The document does not include a tolerance requirement for the alignment of roof panel ribs with those of wall panels. This is because research shows that roof-to-wall panel alignment is seldom controlled during panel installation on buildings with eave overhangs and/or wide eave trims (Bohnhoff and Cockrum, 2004).

Section 5: Metal Trim Positioning

Section 5 contains tolerances for the relative orientation and camber (i.e., edge curvature) of metal trim, trim edge-to-panel rib spacing, and corner trim bend angle.

Section 6: Fastener Installation

Fastener installation tolerances control drive angle, sealing washer compression, framing penetration, and horizontal and vertical alignment of through-panel fasteners. The combination of drive angle, sealing washer compression, and framing penetration requirements help ensure a proper and long lasting seal. If a fastener does not meet framing penetration requirements (e.g., it misses all or a portion of the underlying frame), it can to be removed and redriven at a different angle through the same hole (in an attempt to meet the penetration requirement) as long as the new drive angle meets drive angle requirements. If this does not work, the installer is allowed to plug the hole with a special corrective screw (aka a goof screw) or by driving a fastener through the hole and into a wood block or steel washer/backer plate that has been placed on the backside of the panel. Sealing a panel hole with sealant is not recommended.

Section 7: Surface and Edge Blemishes

Section 7 establishes limits for shallow and deep scratches, scuffs, scrapes, dents, rib kinks and edge kinks. It also addresses removal of metal chips, cutting with an abrasive blade, and oil canning. It also requires that all deep scratches and scrapes on wall and roof panels and exterior trim be touched-up using paint approved by the supplier/manufacturer of the panels/trim.

Appendix A: Measurement Equivalencies

This appendix helps individuals express tolerances in different ways. Specifically, it explains conversions between tolerances expressed as fractions of component length, percent slopes, and angles in degrees.

Appendix B: Recommended Panel Fabrication Tolerances

If variances from specified panel dimensions are not controlled during panel fabrication, it can be difficult, if not impossible for those erecting the building to meet installation tolerance for panels and trim. For this reason, builders may benefit by establishing panel fabrication tolerances. To guide builders in this effort, Appendix B contains recommended tolerances for fabricated panel length, end cut, cover width, and edge camber.

Appendix C: Galvanic Corrosion

Galvanic corrosion is a common form of corrosion that occurs when dissimilar metals or metal alloys are brought into electrical contact by immersion in a conductive electrolyte. In the case of building materials, this conductive electrolyte is generally impure water (e.g., rainwater, groundwater). When electrically connected, one of the dissimilar metals becomes the anode and corrodes faster than it would alone in the conductive electrolyte, while the other metal becomes the cathode and corrodes slower than it would alone in the conductive electrolyte. Because minimization of galvanic corrosion plays a critical role in panel, trim, and fastener selection, it is covered in detail in Appendix C. One feature of this appendix is the table on page 37 (i.e., Table C.2) which gives fastener recommendations for different panel/trim surface materials. This appendix also addresses galvanic action between fasteners and preservative-treated lumber.
Appendix D: Panel and Trim Design/Selection Considerations

The quality of metal panel and trim installation is influenced, in part, by overall building design and component selection. To this end, knowledge of metal panel and trim design/selection considerations is fundamental to discussions involving installation quality, and is included in Appendix D for that purpose. Specific topics included in the appendix include: base metal type, base metal thickness, metallic coatings, paint coatings, structural loads, panel profiles, diaphragm design, panel end laps, lap sealant, cool roofs, metal trim properties, vent and closure strips, and gutters.

Summary

A document entitled “Accepted Practices for Post-Frame Building Construction: Metal Panel and Trim Installation Tolerances” was recently approved by the NFBA Board and NFBA Technical and Research Committee. A copy of this document can be purchased by calling the NFBA at (800) 557-6957. Any questions regarding its development can be directed to Dr. David Bohnhoff at the University of Wisconsin-Madison (608-262-9546, bohnhoff@wisc.edu). ■

References


NFBA 2005b. Standards of professional conduct. Available at www.nfba.org