TPI 1-2007 Changes:
Improving the In-Plant Quality Control Standard

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Changes to the industry's quality standard will make component manufacturers' quality control process more efficient.

For many component manufacturers, the winter months allow for time to evaluate plant operations. How can we increase throughput? How can we get components to the jobsite faster? How can we ensure that the components we produce consistently meet a solid standard of quality so that if something goes south on a jobsite we have built in a high degree of risk protection? Can we also reduce callbacks, like others have shown can be done? Are there benchmarks from the data we gather that can point out issues in manufacturing or design before they become costly? These are all good questions that many of you ask.

Let's focus on the quality question. In order to ensure good quality, you first need to figure out what "good" means. What do you think "good quality" is? Once you've answered this question, you need to evaluate your truss manufacturing process to see if it meets your quality expectations. In order to properly evaluate this, you need to have checks in place that make sense.

The Evolution of the TPI 1 Quality Standard

The beginning of the quality checking process for our industry comes from the ANSI/TPI 1 quality standard. This standard is intended to ensure that the trusses produced will perform as designed. In the TPI-1985 Appendix P *Quality Standard for Metal Plate Connected Wood Trusses (QST),* component manufacturers had to have firm embedment in order to comply. It was determined that component manufacturers could not comply with this standard so it was revised significantly within ANSI/TPI 1-1995 Chapter 4 *Quality Criteria for Metal Plate Connected Wood Trusses.* A new embedment gap criterion and the concept of counting teeth in a member to ensure the proper joint capacity were implemented. Given that this was a cumbersome process, the ANSI/TPI 1-2002 quality standard was again revised to find more efficient means to arrive at truss design quality compliance. This standard looked more closely at plate placement on the joint to determine truss quality. The revised 2007 TPI 1 standard will take in-plant quality control (QC) one step further by providing manufacturers with more efficient quality checks, leading to confidence in their production lines and product.

In 2002, the Plate Placement Method (PPM) was implemented to allow for a quicker visual check of the location of all the teeth in a joint. The PPM process called for design software to output Joint QC Details that defined the positioning tolerances for any particular joint of a truss selected for truss inspection as outlined in ANSI/TPI 1 Chapter 3 *Quality Criteria for the Manufacture of Metal Plate Connected Wood Trusses.* As with TPI-1985 Appendix P and ANSI/TPI 1-1995 Chapter 4, ANSI/TPI 1-2002 Chapter 3 addresses the criteria with which manufacturers must comply to meet the standard. Since the introduction of the 2002 standard, the structural building components industry (i.e., component manufacturer users, TPI Technical Advisory Committee and WTCA's QC Committee) has provided feedback on methods to improve and streamline the QC process and provide ever-improving management information.

at a glance

- ❑ Chapter 3 in ANSI/TPI 1 is the section that defines the industry's manufacturing quality control standards.
- ❑ Throughout 2006, a Project Committee has revised Chapter 3 to include feedback from component manufacturers.
- ❑ One significant change involves combining two previous inspection methods into one for increased efficiency.

New Quality Standard Development

In January 2006, the Truss Plate Institute created a Project Committee (PC) for the revision/reaffirmation of the ANSI/TPI 1-2002 standard, *National Design Standard for Metal Plate Connected Wood Truss Construction.* The PC's first task was to update Chapter 3 to account for all the feedback that had been generated by the industry. In August, the PC and TPI TAC recommended that the TPI Board adopt the revised Chapter 3 language until it is formally adopted within the ANSI/TPI 1 standard per the following TPI Board approved statement.

> [TPI] believes that the refinements made within the standard are sufficiently defined that companies can begin implementing theses changes with limited risk of future changes between now and final acceptance of the standard. These changes represent a more up-to-date thinking on methods to achieve quality in the manufacturing and fabrication of metal plate connected wood trusses.

Component manufacturers will not have to wait much longer before obtaining designs that can be inspected under the "new" inspection method which will eventually be part of the 2007 edition of TPI 1. The revised TPI 1-2007 Chapter 3 will:

- Allow the **In-Plant WTCA QC** manual to be updated and then used as a comprehensive QC manual that follows the guidelines of TPI's third party inspection program which is based in part on the ICC's *Acceptance Criteria for Quality Control Manuals* (AC-10).
- Allow component manufacturers more flexibility with setting the specific fabrication tolerances their operation will use based on their actual production quality performance.
- Combine the Plate Placement Method (PPM) and the Tooth Count Method (TCM) into one inspection method (thus eliminating ANSI/TPI 1-2002 Annex A3).
- Make it possible to have a consistent Joint QC Detail including two tolerance polygons to more quickly and easily analyze the joint being inspected.
- Change the calculation of the Joint Stress Index (JSI) to be easier to understand.
- Allow for alternative inspection methods that provide component manufacturers with the ability to craft the inspection program to meet their plant's operational needs.

Each of these changes is described in detail below.

AC 10

AC 10 is the Acceptance Criteria that the ICC Evaluation Service has created as a template for what is reasonable to include in a manufactured product's quality control manual. Just like the **In-Plant WTCA QC** program and the TPI 1 Chapter 3 commentary, AC 10 is a tool or guide to help the plant meet the building code and inspection agency requirement that each plant have a quality control program and an accompanying quality control process.

The specific implementation language, which has been in the building code and part of TPI's third party quality assurance program for at least the last decade, follows:

> **Consensus Standard Developed and Proposed TPI 1-2007 3.1.1:** Chapter 3 is the quality standard for the manufacturing processes of metal plate connected wood trusses, and shall be used in conjunction with a manufacturing quality assurance procedure and a truss design. These provisions shall be included in the In-Plant Quality Assurance Program of each Truss Manufacturer.
>
> **Consensus Standard Developed and Proposed TPI 1- 2007 3.2.1:** An in-plant quality control manual shall be maintained for each truss manufacturing facility, which will include the requirements for daily quality control and any audits that will be performed. At a minimum, the in-plant quality control manual shall contain: (1) either a production flowchart or a description of the manufacturing process, (2) manufacturer's organizational

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chart, and a description of the duties and responsibilities assigned to key positions in the quality program, (3) quality control procedures, including sampling criteria and how manufacturing processes are monitored to ensure that the product is consistently manufactured within the allowable tolerances, and (4) a document retention policy.

Over the last year, WTCA has worked with TPI to provide **In-Plant WTCA QC** users a framework that makes it easy for them to put in place a QC manual that complies with the requirements of AC 10.

Fabrication Tolerance Flexibility

The proposed changes give the component manufacturer more flexibility in determining the fabrication tolerance. The fabrication tolerance is set in the design process to allow for lumber characteristics (e.g., knots and wane) and/or flattened teeth in the plate contact area. In the 2002 standard, if a manufacturer did not want to count teeth to assure that their roof truss plating was correct, they had to select a fabrication tolerance that assumed reduced tooth holding characteristics consumed 20% of the plate contact area. For floor trusses, this tolerance was 10%. The 2002 standard did not allow for any variations between 0-20%, even though this amount of variation is often the case, and if a manufacturer wanted to account for the fact that their plate contact areas consistently had less reduced tooth holding characteristics, they had to count teeth.

Table 6.4-5 Quality Control Factor

Fabrication Tolerance	C_q Factor
0%	1.00
5%	0.95
10%	0.90
15%	0.85
20%	0.80
25%	0.75
30%	0.70

Figure 1: Consensus Standard Developed and Proposed TPI 1-2007 Table 6.4-5. [Note: These are example fabrication tolerances for a given C_q factor. The actual C_q factor shall be based on the fabrication tolerance set by the Truss Manufacturer.]

TPI 1-2007 will allow manufacturers to dial in any fabrication tolerance they choose. For example, if the manufacturer knows that, on average in their plant, 10% of the contact area has reduced tooth holding characteristics, they can now set the fabrication tolerance to 10% (i.e., C_q = 0.90). If the manufacturer controls the amount of knots and wane that it allows in the plate contact area to zero, it can now set the fabrication tolerance to account for the typical reduced tooth holding characteristics that it would see which should be approaching zero. To help illustrate, the revised TPI 1-2007 contains Table 6.4-5 (see Figure 1 above).

Plate Placement & Tooth Count Combined into ONE Inspection Method

In ANSI/TPI 1-2002, depending on the C_q factor used (now described as the fabrication tolerance), the manufacturer inspected using either the Plate Placement Method (PPM) or Tooth Count Method (TCM).

TPI 1-2007 combines these two methods into one inspection process comprised of a series of steps. If necessary, the last step will be to count teeth. With the foregoing approach, the inspection process will be more clearly defined. In a future article, we will describe the inspection method in greater detail and highlight each feature of the updated Joint QC Detail described next.

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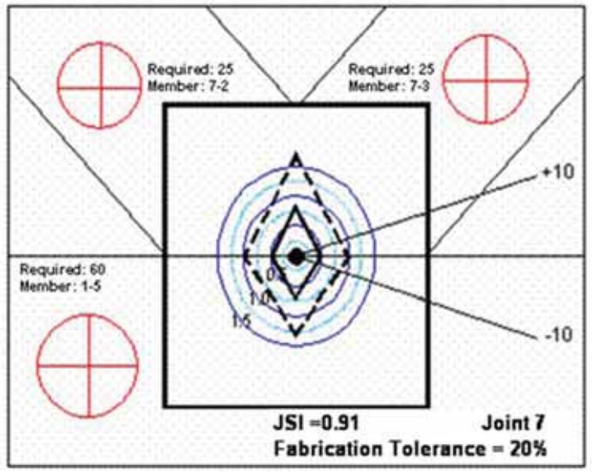

Figure 2: Consensus Standard Developed and Proposed TPI 1-2007 Figure 3.7-1 - Example of a Joint QC Detail and Fabrication Tolerance Polygons

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Improved Joint QC Detail

One of the goals of the 2007 changes was to make the Joint QC Detail a better quality management tool. The new Joint QC Detail (see Figure 2) will have two tolerance polygons to more quickly and easily analyze the joint being inspected.

In all cases, the Joint QC Detail will also have the required teeth listed for each member in case the inspection calls for teeth to be checked.

JSI Calculation

> **ANSI/TPI 1-2002 Section 8.12.3.1:** ...the Joint Stress Index (JSI),...shall be determined for each joint as the largest ratio of applied force to allowable design force determined from all portions of Chapter 8. ...

Under PPM, the JSI was calculated using an allowable design force that was reduced by the checks required in Chapter 8 including lateral resistance. The JSI will be calculated based on 100% tooth holding values under TPI 1-2007. This will lower the JSI because the applied force will remain the same but the allowable design force will be larger. Any time you divide by a larger number you get a smaller result. Joints are selected for inspection only if the JSI is high. Lower JSIs mean that manufacturers need to inspect less joints.

Some manufacturers are seeing high numbers of critical joints per inspection. There will also be much more variation in the fabrication tolerance manufacturers select. To account for this, the JSI would be determined by what is known (i.e., required teeth, shear and tension) rather than lumber characteristics and/or rolled teeth that may or may not exist. By taking lumber characteristics and/or rolled teeth into account with the fabrication tolerance, but basing JSI on 100% tooth holding, critical joints will decrease.

Alternative Inspection Method Flexibility

A small language change in TPI 1-2007 allows for alternative inspection procedures to be used to assess plant quality, which offers manufacturers more flexibility but

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Preliminary Check Truss Inspection Form

Frequency: 3 Trusses Per Set-Up Location Per Week - Inspect Non-Critical Joints On Each Side Of Truss

Inspection: PPM☐ TCM☐ Inspection Number:_____ Inspection Date:_____ Inspection Time:_____ Inspector:_____ Line/Table:_____ Shift:_____ Crew:_____ Job/Drawing Number:_____ Truss Design/Truss ID:_____ Truss Type: Roof☐ Floor☐ C_q Value:_____

Note for PPM: Roof: C_q = 1.00 Floor: C_q = 1.11

Note for TCM: C_q likely = 1.25

1/32"

Preliminary Check	OK?	if no...
1) Do truss dimensions conform to design (span within 3/4" and height within 1/2")?	yes no	
2) Does all lumber conform to design (top chords, bottom chords, and webs)?	yes no	
3) Do all plate sizes conform to design (both dimensions must be equal to or greater than specified)?	yes no	
4) Are all plates properly embedded (including less than 1/32" gap and without excessive rolled teeth and lumber characteristics)?	yes no	
5) Do all plates have visibly acceptable placement (including rotation 10° or less and actual midpoint appears close to specified midpoint)?	yes no	
6) Do all joints clearly have an acceptable member to member gap (within 1/8" or within 1/16" for floor truss splices)?	yes no	

Truss Dimensions (ft-in-16th)

Component	Actual	Specified
Span		
Overall Height		

Lumber Information

	Actual			Specified		
Member Type	Grade	Species	Size	Grade	Species	Size
TC BC W						
TC BC W						
TC BC W						

if no... Joint Number	Side	Comments (list specific cause for failure and decided remedy)
	F/B	
	F/B	
	F/B	
	F/B	
	F/B	
	F/B	
	F/B	
	F/B	
	F/B	
	F/B	
	F/B	
	F/B	

Initials verifying that errors on form have been corrected: _____

Figure 3: **In-Plant WTCA QC** Preliminary Check Truss Inspection Form

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still allows plants to meet the ANSI/TPI 1-2002 inspection frequency (currently three trusses per set-up location per shift per week). This alternative method will involve the manufacturer performing two checks:

1) Perform an inspection, similar to the **In-Plant WTCA QC** preliminary inspection (see Figure 3), at the current inspection frequency; and
2) Inspect random critical joints, using the fabrication tolerance polygons described in Figure 2 (page 40), for a minimum of ten critical joints per set-up location per shift per week.

This alternate inspection method will be outlined in the **In-Plant WTCA QC** manual and also in the TPI-1 2007 Chapter 3 commentary so manufacturers can take advantage of the alternative procedure's flexibility.

Conclusion

The QC standard and inspection procedures have come a long way in recent years. Each manufacturer has the challenge of maintaining a satisfied customer base and meeting deadlines while making sure it is manufacturing a quality product. We have worked with all the manufacturers using **In-Plant WTCA QC** and WTCA's QC Committee to revise the TPI 1-2007 language to reflect their ideas on improving the efficiency of the inspection methods. Next month we will update readers on some of the recent changes that have been made to the **In-Plant WTCA QC** program to improve its use as a quality management system. SBC

If you have any questions on these TPI 1-2007 QC standard changes please contact Ryan Dexter (608-310-6744, rdexter@qualtim.com) or Tony Piek (608-310-6713, tpiek@qualtim.com).

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