3rd Party Inspection/Audit: Your Partner in Quality Control

by Charles B. Goehring, Truss Plate Institute Director of Inspection Services

Why you should view 3rd party quality control inspection as friend, not foe.

On occasion, new truss manufacturer applicants to TPI's 3rd Party Quality Assurance Program do not like having to subject their operation to independent audit and inspection by an accredited 3rd party agency. They cite that their sole reason for hiring a 3rd party is to comply with IBC Section 2303.4, which was required in a job specification. Some also question the cost of implementing in-house quality monitoring and some are uncomfortable inviting an outside entity to inspect and audit their QC activities.

3rd Party Unbiased Assessment

By having a 3rd party audit your operation's quality assurance procedures and records, it allows for an unbiased assessment of how well your operation is complying with the requirements of the building code. For truss manufacturing the provisions to meet these code requirements are found in ANSI/TPI 1-2002 (2007) Chapter 3.

3rd party audits also demonstrate to those outside the business that there is a recognized QC program in place which is being appropriately implemented. During the course of the 3rd party visit, the auditor should encourage the QC technician to observe or jointly inspect a truss as an on-going training opportunity. During the audit and inspection, the 3rd party agency should provide important feedback as to how well your operation is complying with mandatory ANSI/TPI 1 quality tolerance criteria, as well as comment on specific manufacturer driven protocols to help improve your QC operations.

All of these measures are designed to help you improve your QC program. This article outlines some of the ways, based on our experience, a 3rd party can be a valuable partner as opposed to a code-mandated evil.

TPI 1 Requirements

TPI 1 outlines the minimum requirements for QC in Chapter 3. There have been major changes in the 2002 ANSI/TPI 1 QC chapter from the previous 1995 chapter. The 2002 both simplifies and more clearly defines the inspection frequency and inspection criteria. And while the 3rd party inspection process itself did not change in the 2002 edition, it was given greater emphasis to standardize the various ways in which the process was being interpreted by inspectors. The implications of this impacted 3rd party inspection agencies as well as manufacturers. The services previously provided by 3rd party agencies when adhering to ANSI/TPI 1 – 1995 and earlier were primarily focused on in-plant inspections. Under the 2002 edition, more emphasis has been placed on auditing or validating that the QC process is reasonably correct.

In most instances plants are knowledgeable about the typical items related to QC inspection criteria. However, the most recently added items relating to set-up location and representative sampling are not always documented (see section 3.2.2 and 3.2.3 of ANSI/TPI 1) or well understood.

at a glance

- A 3rd party can assist with your QC program and be a valuable partner.
- Set-up location and representative sampling are two inspection criteria detailed in ANSI/TPI 1 that can be easily misunderstood.
- Being able to adjust inspection frequency as the production levels fluctuate is an efficient use of personnel's time.
- By consistently logging QC data, one plant was able to lower their default settings to 5° because crews were plating at a lower plate rotational level.

> 3.2.2 At a minimum, 3 trusses per week per set-up location per shift shall be inspected and recorded for in-plant audits.
>
> 3.2.3 A random representative sampling of trusses shall be chosen for inspection, either off the production line after all pressing operations are completed, or from finished goods storage.

These two sections are important because they provide the sampling criteria which were developed through a consensus process based on what was typically being done in truss plants with quality control departments. Before this was defined, there was a wide array of in-plant QC procedures, so the goal was to have a more consistent approach to quality control procedures. These sections have become the baseline that a 3rd party agency uses to determine whether the sampling criteria are reasonably met.

Set-up Location

Let's first look at set-up location as discussed in section 3.2.2. Surprising as it may sound, some component manufacturers struggle to clearly define their "operational set-up locations," which has a direct bearing on how much time and staffing needs to be devoted to their truss QC sampling regimen. Of late, the questioning of resources has been exacerbated by the slow down in the residential truss manufacturing market, which contributes to a fluctuating and transient work force. Because of this, some manufacturing locations have tended to short shrift their in-plant quality monitoring by devoting less resources (staff, money, etc.).

A quick review of ANSI/TPI 1-2002 Section 3.2.2's Commentary states:

> *"although set-up location in the inspection frequency is not strictly defined, it is intended that each truss manufacturer plant will establish reasonable, manageable-sized groups in each work shift from which 3-trusses per week will be inspected and recorded for the in-plant audit. For example, a 'set-up location' might be defined as a crew, or group of personnel within a defined work area building one truss. If defined as such, then each 'crew' during each work shift will have a minimum of 3 trusses inspected per week."*

A simple solution to meet the criteria is to document the specifics in the plant's in-house QC manual. Specific examples could be to:

- first define how they determine a "set-up location" using the criteria found in TPI 1 and to identify on their shop floor plan the maximum number of "set-up locations" where trusses can be built.
- establish a QC-Production Log Entry Sheet that is regularly updated and captures when the set-up location was building trusses on a daily and weekly basis to meet the requirements of the TPI standard, allowing the company's QC technician to ramp up or down their truss inspection frequency.

As a rule of thumb we often advise QC technicians to inspect at least one truss if the set-up location is working up to 13.333 hours per week, two trusses if the set-up location is working up to 26.667 hours per week, and three trusses if the set-up location is working more than 26.667 hours per week, and zero trusses inspected when the set-up location is idle for a particular week.

Being able to ramp up or down on inspection frequency as the production levels fluctuate is an efficient use of personnel's time. It also allows for an ongoing documentation of the process. By recording each and every set-up location activity, a prorated QC truss sampling regimen is not only reasonable but easily justified.

For example, a typical 140-foot roller gantry line with a finish roller system could accommodate three set-up locations. If all three stations (A, B and C) are building trusses for the better part of a work week with three cohesive crews, a 3rd party

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agent would expect, per ANSI/TPI 1-2002 Section 3.2.2, that nine trusses were inspected for quality during that particular period. (See WK I in Figure 1.)

However, it is common to find in subsequent weeks for the same manufacturing facility, where Station A and B might be combined to build long-span post frame trusses, leaving station C for the mid-span trusses. If the "QC-Production Log Entry Sheet" is keeping track of station activity, it could then show station A as being active throughout the week, while Station B is inactive since its space has been taken up by an expanded Station A with crews from A and B being combined. In this case, three trusses would be selected for combined Station A and B, and three trusses selected for Station C; this would result in six trusses being inspected for the same 140-foot roller gantry line during an entirely different time frame. (See WK II in Figure 1.)

Another possible assembly scenario for the same 140-foot roller gantry line might involve a roving (skeleton) crew building trusses at all three stations throughout the work week. This has been particularly evident during periods of slow production and significantly scaled back staffing. For example, a roving crew might start out setting up a large post-frame job at Station A and B for up to 26.667 hours of the week, but on and off throughout the remainder of the week shift out a portion of its remaining 13.333 hours building stock residential trusses at Station C. In this case, two trusses would be inspected for combined work station A and B and one truss inspected for Station C. (See WK III in Figure 1.)

Sample QC Production Log

WK I

Setup Location	Crew	Days of the week: M	T	W	T	F	S	S	Mgmt Initials	Hrs Worked	Min. truss to be inspected
A	1	8	8	8	8	8				40	3
B	2	10	10	10	10	0				40	3
C	3	0	10	10	10	10				40	3

WK II

Setup Location	Crew	Days of the week: M	T	W	T	F	S	S	Mgmt Initials	Hrs Worked	Min. truss to be inspected
A/B	1&2	8	8	8	8	8				40	3
										0	0
C	3	6	6	6	6	6				30	3

WK III

Setup Location	Crew	Days of the week: M	T	W	T	F	S	S	Mgmt Initials	Hrs Worked	Min. truss to be inspected
A/B	1	8	8	8	2.7					26.7	2
										0	0
C	1				5.3	8				13.3	1

Sample Setup Location: 140' Roller Gantry Line

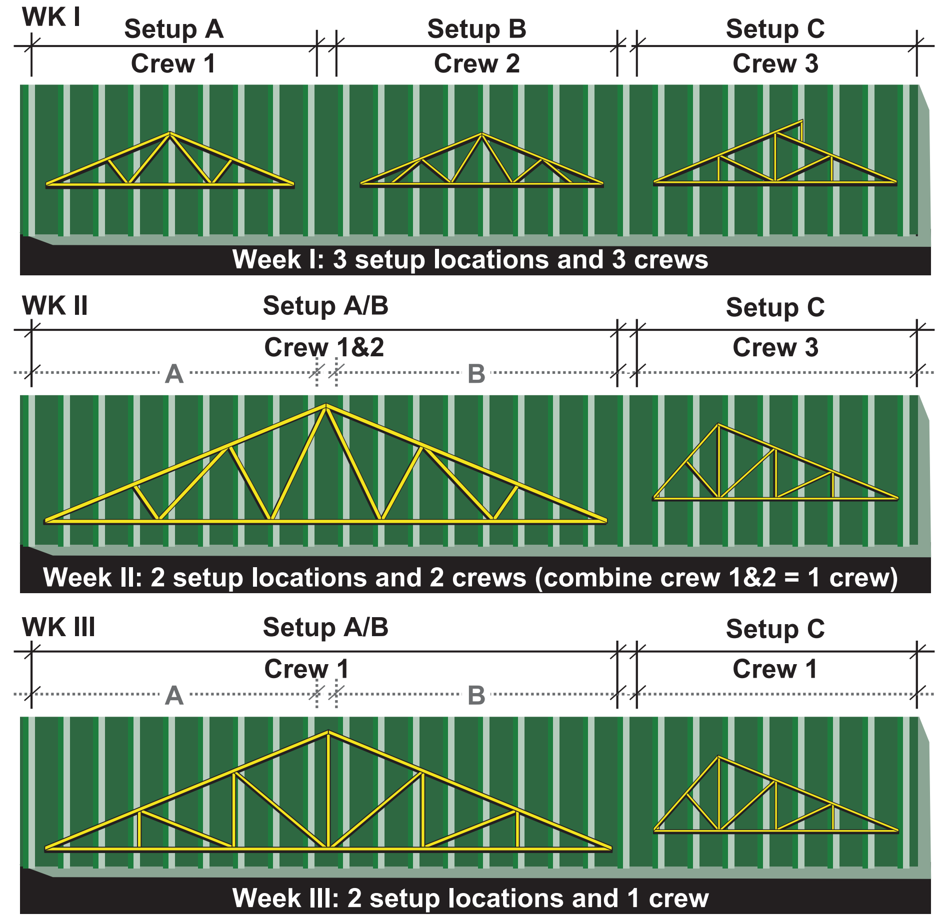

Figure 1. Typical 140-foot roller-gantry scenarios.

By keeping track of the time spent at set-up locations when trusses are actively being built during a particular week, the QC technician can readily scale up or down the three-truss QC sampling rule. As the above three scenarios suggest, this approach allows for flexibility and is a reasonable accommodation to a dynamic staffing and work space environment. To assure ongoing accountability, we urge all licensees to have their weekly QC-Production Log Entry Sheets reviewed, signed and dated by upper management the following week. It has been found that by involving upper management's review, a new set of synergistic interactions increase accountability and foster a desire to learn from your QC observations.

A number of our licensees recently observed that when business was slow, they found themselves working with significantly scaled back work forces, leaving them with their best and most seasoned assemblymen. To keep assemblymen motivated and loyal, they would often bring them in for partial work weeks and rotate "skeleton crews" throughout any number of different set-up locations.

Most of their in-house QC sampling was structured around the tracking of scaled back roving crews, and the number of trusses QC'd were significantly less than when they were fully operational. Keeping track of so called "cohesive crews" became cumbersome and difficult to manage as production started to ramp up. Also, as they strived to co-mingle seasoned personnel with new hires, their crew makeup was constantly changing and cohesiveness difficult to achieve. By structuring QC sampling along the lines of how much activity was taking place at the set-up locations, the licensees were better able to meet their in-house QC sampling quotas by ramping up their sampling with increased production and scale back when production slowed. Furthermore, we highly recommend that your weekly QC log sheets are reviewed and signed by upper management.

Builders FirstSource recently state, TPI's suggested accountability protocols have instilled a higher level of interest by our QC personnel in that their work is appreciated by not only the assemblers but by upper management as well. TPI's inspection frequency requirements allow flexibility to adjust the number of required inspections based on varying schedules. All in all we do not consider TPI so much as a monitoring agency, but rather as a business partner.

Representative Sampling

Section 3.2.4 of ANSI/TPI 1 – 2002 states that "A random representative sampling of trusses shall be chosen for inspection, either off the production line after all pressing operations are completed, or from finished goods storage." How a plant chooses a "random representative sampling of trusses" is an interesting challenge facing QC personnel. Clear-cut sampling rules should be defined and outlined, preferably in the in-plant QC manual, and upper management should review the process in order to be assured that small, easy to inspect trusses are not chosen over longer span trusses. Unless your business is devoted to small span trusses solely, consistently ignoring longer span trusses will compromise the integrity of your program.

Span	Inspections	% of Inspections	Target % 2006
0-10	62	20.20%	27.80%
11-20	72	23.50%	18.20%
21-30	132	43.00%	32.20%
31-40	35	11.40%	14.50%
41-50	5	1.60%	4.40%
51-60	0	0.00%	1.70%
61-70	1	0.30%	0.90%
71+	0	0.00%	0.30%
Total	307	100%	100.00%

Figure 2. Example of 10-foot incremental spans.

The key to reasonable QC sampling is found by defining what is representative? Often we will urge manufacturers to review last year's records and determine what percentage of trusses were in any number of span ranges (see Figure 2), and use them as targets for the coming year's QC sampling regimen. Note, this particular snapshot happens to be the halfway point in the year. This manufacturer noted it might want to instruct its QC technician to focus more of its QC inspections in the 0- to 10-foot category, scale back somewhat in the 10- to 30-foot category, and increase slightly QC sampling in the plus 30-foot category for the remainder of the year. By integrating upper management review with the QC sampling process, the manufacturer can fine tune its in-house inspection process and demonstrate that its sampling is "representative" of its production. If production characteristics significantly change, reassessing new target span percentages on a semi-annual basis makes sense, which can cause an adjustment in its QC span sampling.

These common sense approaches to QC truss sampling were generally developed in consultation with participating licensees of TPI, and are passed on by TPI Agents to other licensees as their particular in-house QC needs may dictate. TPI constantly advises truss manufacturers that from a risk management perspective, it is important to have viable QC records of product that are truly representative of its output. However, staving off risk should not be the sole reason for evaluating your product.

A manufacturer's QC observations, both good and non-conforming, need to be utilized to their fullest maximum advantage in the production and design feedback process. For example, tracking your QC observations via a database management system, such as WTCA QC 4.3 or equivalent, can help in the design and manufacturing decision making process. For example, the midpoint distance of an installed plate from specified midpoint, actual rotational degrees, and required versus actual tooth counts provide numerical values that can be analyzed. Tangible benefits can result over time, particularly where a consistent stream of conforming QC observations result in more efficient design.

TPI's primary motivation is to help component manufacturers establish a quality assurance protocol centered around the ANSI/TPI 1-2002 Section 3's Quality Criteria. We hope this article and the accompanying case studies (see pages 28-29) help demonstrate this while providing useful tips you can begin to implement in your own QC program. We have found that stressing the need for useful QC documentation and data, encouraging upper management's involvement and feedback in the process, and providing quality 3rd party inspection and audit services will foster a QC esprit de corps that will lead to continuous process improvement and improved product performance. SBC

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Case Study 1:

Tracking plate rotation can lead to more competitive designs

[Truss Specialists]

An audit of Fabricator A's full scale QC details shows their observed plate rotations for the back (blind) side plating was averaging around 2° with an occasional maximum rotation of 5°. TPI Agents noted that if the actual degree information was recorded rather than a minimum passing Yes, a compelling case could be made later via statistical analysis (recommend WTCA In-Plant QC 4.3) to the design department that its assemblymen are doing a much better job than the Plate Option default setting of plus/minus 10° plate rotation might otherwise allow. With a sound statistical base of complimentary QC data, the design team could opt to change their default settings to 5° since the shop is consistently plating at a lower plate rotational level. A 5-degree rotational allowable compared to the same plate solution with its corresponding 10-degree rotational allowable generally results in more efficient (smaller) plate size solution. In this case, good quality can be rewarded with more competitive truss designs.

However, in the event that plate rotation starts to creep up and exceed the recently enacted 5-degree allowable, your ongoing QC monitoring system should be sensitive enough to detect early on and make the appropriate adjustments (i.e., retraining, preplating away from the blind side, or resetting the rotational tolerance allowable back up to the actual average rotation or 10° or higher). Also, it is not too far fetched to develop joint design settings customized to particular operational set-up locations. The ability to track how well one operational set-up location is doing compared to another and all within the same manufacturing location can be best accomplished by keeping your in-house QC data in WTCA In-Plant QC 4.3 database management system.

When the TPI Agent visited us recently, he complimented us on the accuracy of our plate placement (less than 3/8" from the design midpoint of the tolerance polygon) and excellent plate rotation (2-3 degree maximum); all without the aid of a laser projection system. Our WTCA QC database findings coupled with TPI's audit of our last two weeks of inspection reports and their confirmatory truss inspection assured us of the viability and accuracy of our plate rotation findings. Because of exceedingly good rotational observations that are well within our default settings of plus/minus 10°, we are able to give serious consideration toward a plate setting change in our design program.

However, being conservative truss designers by long standing practice, we will be cautious and take a wait-and-see approach for a month or two to determine if these encouraging trends are sustainable.

We value TPI's involvement in our QC process as a helpful and friendly means of improving our bottom line while assisting us foster an "esprit de corps" with all, particularly the assemblers, who benefit directly from our in-house QC program.

Case Study 2:

Documenting plate positioning allows adjustments to allowable defect settings

Fabricator B designs its plates with a zero percent defect allowable (known as tooth count method), and adds 4/16" additional plate dimension on all four plate sides. Their initial logic to this joint design approach was to provide additional plate coverage over and above minimum plating to compensate for movement of the truss plate during the pressing operation, and perhaps less than stellar plate placement on the blind or table side. However, as a result of on-going in-house QC monitoring, they have found that their installed plate's midpoint rarely exceeds the zero percent (TCM) tolerance polygon for plate positioning (generally ½" radius minimum). Thus, due to excellent and well-documented plate positioning values (observed actual averaging ¼" radius from specified midpoint), the manufacturer decides to change its defect allowable to 20 percent and as a trade-off reduce its additional plate dimension add-on from 4/16" to 2/16", with the added benefit of saving in-house QC time. Upon further QC evaluation and continued good plate placement, it elects to stay with the 20 percent defect allowable (plate placement method) and save on plates further by reducing the additional plate dimension add-on from 2/16" to no add-on. The moral of this story is good plate placement is rewarded with more efficient plate design solutions.

Case Study 3:

Stress Document

Fabricator C (North Plant and South Plant) designs their plates with a 20 percent defect allowable and 2/16" of extra steel on each plated edge. Their initial logic to this approach was to provide a buffer to allow for lateral resistance-reducing lumber characteristics such as loose knots and wane to be present in limited amounts in the plate contact areas. During the course of their ongoing QC, they discovered that two out of three member contact areas (mostly web stock) had lumber characteristics that filled in about 50 percent of the defect circle allowable. In addition, five percent of all member contact area (mostly web stock) had to be reevaluated with the tooth count method because the defect circle was filled in by more than 100 percent, which often resulted in most of these joints failing anyway because actual tooth counts were less than required. The net result of all this was failed plates needed to be replaced with larger ones and assembly time was reduced due to an inordinate number of lumber related characteristics negatively affecting plate contact areas.

Fabricator C's North Plant decides to change its web stock from Stud Grade S-P-F to #1/#2 S-P-F. Their logic centered on smaller lumber characteristics, based on the higher visual grade, should not adversely overwhelm the 20 percent defect circle allowable. During the course of their on-going QC they discovered that one out of three member contact areas had lumber characteristics that filled in only 25 percent of the defect circle allowable and no re-evaluation via the tooth count method due to a lower incidence of lumber characteristics compromising tooth integrity. Thus, the change to a higher visual web stock grade virtually eliminated lumber related repairs. Upon further QC data input, Fabricator C's North Plant decides to do away with the 2/16" of extra steel, and/or will consider changing its 20 percent defect allowable to 10 percent once ANSI/TPI 1-2007 becomes ANSI approved. Either approach will result in more efficient plating solutions, since higher grade lumber and its correspondingly smaller lumber characteristics have a lesser tendency to compromise available plate contact areas.

Fabricator C's South plant decides to stay with Stud Grade S-P-F for its web stock due to high lumber inventory levels and no secondary markets to sell off their Stud Grade. They approached their problem a different way by boosting the 20 percent defect allowable to 30 percent while retaining the 2/16" of extra steel on each plated edge. During the course of their on-going documented QC they discover 2 out of 3 member contact areas now have lumber characteristics that fill in only 25 percent of the defect circle allowable, and no member contact areas needing re-evaluation via the tooth count method. Their slightly larger plate solutions adequately compensated for Stud Grade lumber characteristics by providing for a larger defect circle allowable based on 30 percent reduction in their grip value rather than a small defect circle per the 20 percent reduction factor. As further QC'ing proceeds they'll give serious consideration toward removing the 2/16" of extra steel on each plated edge. SBC

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