ACCEPTANCE CRITERIA FOR PREFABRICATED WOOD I-JOISTS

AC14

Approved October 2007

Effective February 1, 2008

Previously approved June 2004, October 2003, September 2003, July 2000, March 2000, July 1996, July 1993

PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the *International Building Code*® reads as follows:

> The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

This acceptance criteria has been issued to provide all interested parties with guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. The criteria was developed and adopted following public hearings conducted by the ICC-ES Evaluation Committee, and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from the previous edition, a solid vertical line (**I**) in the margin within the criteria indicates a technical change, addition, or deletion from the previous edition. A deletion indicator (➜) is provided in the margin where a paragraph has been deleted if the deletion involved a technical change. This criteria may be further revised as the need dictates.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

ACCEPTANCE CRITERIA FOR PREFABRICATED WOOD I-JOISTS

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish minimum requirements for recognition of prefabricated wood I-joists in evaluation reports under the 2006 *International Building Code*® (IBC), the 2006 *International Residential Code*® (IRC), the BOCA® *National Building Code*/1999 (BNBC), the 1999 *Standard Building Code*© (SBC) and the 1997 *Uniform Building Code*™ (UBC).

1.2 Scope: The prefabricated wood I-joists are used in lieu of sawn lumber joists and rafters. The I-joists are limited to use in combustible construction.

1.3 Codes and Reference Standards:

1.3.1 2006 *International Building Code*® (IBC), International Code Council.

1.3.2 2006 *International Residential Code*® (IRC), International Code Council.

1.3.3 BOCA® *National Building Code*/1999 (BNBC).

1.3.4 1999 *Standard Building Code*© (SBC).

1.3.5 1997 *Uniform Building Code*™ (UBC).

1.3.6 ASTM D 5055-04, Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-joists, ASTM International.

1.3.7 ASTM D 7247-07a, Standard Test Method for Evaluating the Shear Strength of Adhesive Bonds in Laminated Wood Products of Elevated Temperatures, ASTM International.

1.3.8 ASTM E 119-00, Test Methods for Fire Tests of Building Construction and Materials, ASTM International.

1.3.9 AWPA N2-05, Standard for the Preservative Treatment of Composite Wood Products by Nonpressure Process, American Wood Preservers' Association.

1.3.10 AWPA U1-04, Use Category System: User Specification for Treated Wood, American Wood Preservers' Association.

2.0 BASIC INFORMATION AND REPORTS OF TESTS

2.1 Definition:

2.1.1 Prefabricated Wood I-joist: A structural member manufactured using sawn or structural composite lumber flanges and wood structural panel webs, bonded together with exterior-type adhesives, forming an "I" cross-sectional shape.

2.2 Testing Laboratories, Reports of Tests and Product Sampling:

2.2.1 Testing Laboratories: Laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports.

2.2.2 Test Reports: Test reports shall comply with AC85. All reports shall be issued or certified by an accredited testing laboratory. Tests conducted at a manufacturer's facility must be under the control of and witnessed by an accredited testing laboratory. The manufacturer's test facility is considered a subcontractor of the accredited laboratory.

2.2.3 Test Specimens: Specimens shall be sampled in accordance with Section 3.0 of AC85 and Section 2.2.4 of this criteria.

2.2.4 Specimen Sampling Methods: Specimen sampling methods shall comply with Section 6.1.1.1 of ASTM D 5055.

2.2.5 Specimen Description: Measured dimensions shall be recorded for each specimen in accordance with the degree of accuracy specified in the ASTM Standards. Additionally, statements indicating whether specimens were produced in accordance with the minimum requirements of the approved quality control manual are needed.

2.2.6 Test Results: The failure mode for each specimen shall be described.

2.2.7 Test Conclusions: Test results shall be limited to species and grade of lumber used in wood I-joists tested unless additional data is submitted justifying extrapolation of test results to a range of material composition.

2.3 Test Standard and Analysis:

2.3.1 General: Testing and analysis of test data shall be conducted in accordance with this criteria and ASTM D 5055. In addition, for I-joists with flange depths of less than $1^{5}/_{16}$ inches, full-scale horizontal diaphragm testing is required. The diaphram test protocol shall be acceptable to ICC-ES staff.

2.3.2 In-house Quality Control Testing: In-house quality control testing used to adjust allowable loads published in evaluation reports must be certified by a qualified independent testing agency. Qualification testing used to establish allowable loads must be independently conducted or witnessed by an accredited testing laboratory and shall comply with ASTM D 5055.

2.3.3 Identification: In addition to the details noted in Section 13.1 of ASTM D 5055, the product label information shall also indicate the evaluation report number, flange grade and species. If a product series is unique to a specific flange grade and species and if the relationship between grade, species, and series is shown in the evaluation report, the series designation, rather than flange grade and specie, may be indicated on the product.

3.0 QUALITY CONTROL

3.1 Quality Control Program: The products shall be manufactured under an approved quality control program with inspections by an inspection agency accredited by the International Accreditation Service (IAS) or otherwise acceptable to ICC-ES.

3.2 Quality Documentation: Quality documentation complying with the appropriate sections of Appendices A and B of this criteria and the ICC-ES Acceptance Criteria for Quality Documentation (AC10), shall be submitted.

4.0 EVALUATION REPORT RECOGNITION

4.1 Materials: The flange stock, web material, and adhesives shall be described in the evaluation report.

4.1.1 Adhesives: In addition to the requirements noted in Section 5.3 of D 5055, adhesives used for web-to-web, web-to-flange, and flange-to-flange joints shall conform to heat durability requirements in Section 4.1.2 of this criteria.

4.1.2 Heat Durability: Adhesives shall be qualified for heat durability performance through testing in accordance with ASTM D 7247. The test temperature and heat exposure duration for specimens tested at elevated temperature (Section 7.2 of ASTM D 7247-07a) shall meet the

requirements of Sections 4.1.2.1, 4.1.2.2, 4.1.2.3 and 4.1.2.4 of this criteria.

4.1.2.1 For the bonded specimens, the minimum target bondline temperature shall be 220°C (428°F). For the matched solid wood control specimens, the minimum target temperature at the shear plane shall be 220°C (428°F).

4.1.2.2 The minimum target temperatures in Section 4.1.2.1 of this criteria shall be maintained for a minimum of 10 minutes or until a residual strength ratio for the solid wood control specimens of 30±10% has been achieved, whichever is longer.

4.1.2.3 Block shear testing shall be conducted at a test laboratory room temperature not less than 15.5°C (60°F) immediately after removal from the oven. The time interval from the removal of the test specimen from the oven to the failure of block shear specimen shall not exceed 60 seconds for each specimen tested.

Note: The intent of setting the time interval is to prevent the test specimen bondline or shear plane temperature from dropping more than 5°C (9°F) prior to failure after leaving the oven.

4.1.2.4 The residual shear strength ratio for the bonded specimens, as calculated in accordance with ASTM D 7247, shall be equal to or higher than the lower 95% confidence interval on the mean residual shear strength ratio for the solid wood control specimens.

4.2 Design: The evaluation report shall provide details for the following design considerations:

4.2.1 Shear Design: Allowable loads or reactions shall be reported. Vertical shear load calculations shall include all loads between support faces.

4.2.2 Moment Design: Allowable moments shall be reported based on ASTM D 5055.

4.2.3 Web Stiffeners: Web stiffener requirements established by testing shall be reported.

4.2.4 Lateral Support: The methods providing lateral support shall be reported. The compression flange requires continuous lateral support and the joist ends require restraint to prevent rollover.

4.2.5 Holes: Details established by testing and an engineering analysis shall be provided, such as a chart, figure, or table, showing allowable hole size and location.

4.2.6 Deflection: Formula for uniformly-loaded and concentrated-loaded simple-span I-joists are required.

4.2.7 Bearing Length: Bearing-length requirements established by tests shall be reported.

4.2.8 Duration of Load: Code-prescribed adjustments for duration of load associated with solid-sawn lumber may be applied to wood I-joists and their fastenings.

4.2.9 Repetitive-member Use: Allowable bending moments shall use a repetitive member factor equal to 1.0.

4.2.10 Blocking: Wood I-joists under bearing walls that are perpendicular to the joists shall have full-depth solid blocking at the wall or reaction. I-joists used as blocking panels shall require compression testing to determine load-transfer capacity.

4.2.11 Installation Details: If installation details are provided, substantiating calculations or test data showing compliance with code, or codes, under which recognition is sought.

4.3 Fire-resistance (Optional): Except for recognition of wood I-joists used in assemblies 22-1.1 through 29-1.1 of IBC Table 720.1(3) or assembly 21-1.1 of UBC Table 7-C, wood I-joists used in fire-resistive assemblies require testing in accordance with ASTM E 119.

4.4 Insect Resistance (Optional): Treated I-joists that will resist insect-related degradation shall comply with the following:

4.4.1 Effect on Mechanical Properties: The following tests shall be conducted on treated I-joists. Results of tests shall indicate no effect on the mechanical properties or a proper reduction factor shall be applied.

- Flange stiffness and tension capacity (and finger-joint evaluation) per ASTM D 5055.
- I-joist creep, stiffness and moment capacity per ASTM D 5055.
- I-joist shear and end reaction capacity per ASTM D 5055.
- I-joist interior bearing capacity per ASTM D 5055.

4.4.2 Insect Resistance Effectiveness: The flange and web materials must be listed in the appropriate American Wood-Preservers' Association Standards (e.g., AWPA U1 and AWPA N2) for Use Category 2 (UC2 - Interior Construction Above Ground, Damp), or appropriate termite performance data must be provided that shows the flange and web materials will perform similarly to listed materials.

4.4.3 Effect on Fire-resistance: Information must be submitted indicating what effect the treatment has on the fire-resistance capability of the treated I-joists.■

APPENDIX A

Quality Assurance Guidelines for Prefabricated Wood I-joists

Dated April 1999
(Revised October 2002, April 2007)

Promulgated by Wood I-Joist Manufacturers Association

WOOD I-JOIST MANUFACTURERS ASSOCIATION

QUALITY ASSURANCE GUIDELINES

FOR

PREFABRICATED WOOD I-JOISTS

April 1999

(revised October, 2002)
(revised April, 2007)

FOREWORD

This document was developed by a task group of the Wood I-Joist Manufacturers Association (WIJMA). Its purpose is to outline quality assurance (QA) procedures applicable to the production of prefabricated wood I-joists qualified under ASTM D 5055. Because ASTM standards generally do not cover the details of QA programs, WIJMA members believed that a separate QA document written by the producers would be a valuable resource document for existing and new manufacturers, qualified agencies (or certification organizations) and code evaluators.

As noted in the scope statement, this document does not purport to be all-inclusive. These QA provisions are stated as being minimum requirements, and they must be supplemented with sound engineering judgment and standard manufacturing process controls to serve their function. This document does not preclude the use of other quality assurance programs that provide prefabricated wood I-joist products meeting the intent of this document. On this basis, WIJMA does not represent that all products manufactured in accordance with these provisions will always perform adequately in service. All performance representations and warranties remain the sole responsibility of the prefabricated wood I-Joist manufacturer.

1. Scope

These guidelines define a minimum level of in-house quality assurance requirements to maintain appropriate product performance consistent with design values established in accordance with ASTM D 5055 or in Canada CAN/CSA-O86. They are intended for use by prefabricated wood I-joist manufacturers, qualified inspection agencies (certification organizations), regulatory and evaluation agencies. These guidelines apply to prefabricated wood I-joists which, (1) comply with the requirements of ASTM D 5055, or CAN/CSA-O86 and (2) have current evaluation reports from one or more of the evaluation services. These guidelines do not supersede any requirements of ASTM D 5055 or CAN/CSA-O86.

These guidelines do not preclude the development and implementation of other quality assurance programs that provide quality prefabricated wood I-joist products that meet the intent of this document. Documentation showing equivalency to, and addressing each of the requirements in Sections 3 through 11 inclusive, must be provided.

Quality assurance testing and any applied evaluation criteria are economically only one component of an effective quality assurance program. An economical level of quality assurance testing can only be used to check the process and products on a final basis and should NEVER be relied on as the only criteria in assessing the adequacy of production processes or the product performance. To be effective, any quality assurance program must be developed around the specific component raw materials and the production process and their relative consistency, and must include a high degree of adequate and appropriate process control checks.

In conjunction with the retest requirements contained herein, the production and quality assurance personnel must exercise sound quality assurance judgment in assessing raw materials and production processes. Regardless of test results, evidence of manufacturing deficiencies shall provoke an investigation of cause and corrective action.

These guidelines were developed in light of currently manufactured products, produced from materials defined in Section 5 of ASTM D 5055 or CAN/CSA-O86. New materials may require new or revised guidelines that provide comparable levels of safety and performance.

2. Definitions and Referenced Standards

2.1 Qualified Agency

For the purposes of these guidelines a “qualified agency” is either (1) a qualified agency as defined in Section 8 of ASTM D 5055 or (2) a certification organization as defined in CAN/CSA-O86.

2.2 Approved Lumber Grader

For the purposes of these guidelines an "approved lumber grader" is a person who is qualified for lumber grading practice by training and experience, and is approved by the qualified agency.

2.3 Referenced Standards:

ASTM D 5055 - Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists
ASTM D 2559 - Specification for Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions
ASTM D 1037 - Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D 2395 - Standard Test Methods for Specific Gravity of Wood and Wood-Base Materials
ASTM D 5456 - Standard Specification for Evaluation of Structural Composite Lumber Products
AITC Test T110 - Cyclic Delamination Test
AITC Test T105 - Diagnostic Tests for Joint Quality
ANSI/AITC A190.1 - Structural Glued Laminated Timber
AITC 200 - Inspection Manual for Structural Glued Laminated Timber
CAN/CSA-O86 - Engineering Design in Wood (Limit States Design)
CSA Standard O112 Series-M - CSA Standards for Wood Adhesives
CAN/CSA-O325.0 - Construction Sheathing
NIST PS 1 - Construction and Industrial Plywood
NIST PS 2 - Performance Standard for Wood-Based Structural-Use Panels
NLGA SPS 1 - Special Products Standard For Fingerjoined Structural Lumber
NLGA SPS 4 – Special Products Standard For Fingerjoined Flange Stock Lumber
ANSI/AF&PA NDS– National Design Specification For Wood Construction.
WWPA C/QC 101 – Glued Products Procedures for Mill Certification & Quality Control

Note: *Where applicable this document is based on the standards referenced above. Unless noted otherwise in AC14, it is intended that the most current editions of these standards be used for application of this document.*

3. Independent Inspection

Independent inspection shall conform to Section 8 of ASTM D 5055. Quality assurance audits at each manufacturing plant shall be conducted by the qualified agency. As a minimum the audit shall include but is not limited to review of:

3.1 Quality assurance procedures for inspection and acceptance or rejection of incoming raw materials including disposition of reject material and as needed, review of records kept on incoming and reject material,

3.2 All process controls for each operation in production of the product,
3.3 All quality assurance inspection and testing procedures and frequencies,
3.4 All test data accumulated since the last audit, as needed, and,
3.5 Finished product identification, handling, protection and shipping requirements.

4. In-House Quality Assurance

4.1 Manufacturing Standard - A manufacturing standard that conforms to the requirements of ASTM D 5055, Section 9.1 shall be developed and maintained for each product and each production facility.

4.2 Inspection Personnel – Requirements for inspection personnel shall conform to ASTM D 5055, Section 9.2.

4.3 Record Keeping - All pertinent records shall be maintained in accordance with ASTM D 5055, Section 9.3.

4.4 Testing Equipment - Where applicable all testing equipment shall conform to ASTM D 5055, Section 9.4.

4.5 Periodic Reevaluation - Periodic reevaluation shall be conducted in accordance with Section 11 of ASTM D 5055.

5. Quality Assurance Monitoring

5.1 Objectives

The minimum objectives of a quality assurance monitoring program shall be those stated in ASTM D 5055, Section 9.5.1, and Section 1 of this document.

5.2 Initial Quality Assurance Monitoring

Initial Quality Assurance monitoring shall be in accordance with ASTM D 5055, Section 9.5.2.

5.3 On-going Quality Assurance Monitoring

A monthly summary of the required in-house test data results and analysis shall be prepared by the plant technical director or quality assurance personnel and shall be provided to the qualified agency (or certification organization) in a timely manner. The monthly summary shall consist of statistical data or graphs of the test results along with the disposition of material that did not comply with the manufacturing standard. Any quality assurance or production process discrepancies, noted during the month, by the in-house quality assurance personnel shall be included in the summary along with the action taken to correct the problem.

6. Shear Testing

6.1 Scope

This section defines a minimum level for prefabricated wood I-joist quality assurance shear testing. Individual test, retest and final test requirements are detailed. Additionally, requirements for establishing a shear test database and recommendations regarding trend analysis are provided. For the purposes of this section shear strength is assumed to follow a normal distribution.

6.2 Definitions

6.2.1 *Shear Failure* - A failure of the prefabricated wood I-joist, under load, associated with the web material, connections between web panels or between the web and the flange. For purposes of evaluating shear capacity bearing failure is considered a mode of shear failure, in accordance with Section 6.2.10 of ASTM D 5055.

Note: *For more information regarding common prefabricated wood I-joist shear failure modes see Appendix X5 of ASTM D 5055*

6.2.2 *Test Result (TR)* - The reaction load producing shear failure in a shear test.

6.2.3 *Normalized Test Result (NTR)* - The NTR shall be:

NTR = TR/P

where,

P = Shear design value (working stress design), as defined by Section 3.2.2 of ASTM D 5055.

6.2.4 *Joist Series (Shear)* - Includes all prefabricated wood I-joists which have the same; web type, thickness, and grade, web to flange joint, web to web joint, flange size and type, and the same code assigned shear capacity for a given depth.

6.2.5 Joist Series Group - Includes all prefabricated wood I-joists which have the same web type, thickness and grade, and are fabricated on the same production line, and the same code assigned shear capacity for a given depth.

Note: *When combining joist series into a joist series group, appropriate justification, acceptable to the qualified agency shall be provided.*

6.2.6 *Shift* - For the purposes of this section a shift is the equivalent of 8 to 12 hours of continuous production.

6.3 General Requirements

6.3.1 *Quality Assurance Shear Test* - The quality assurance shear test set up and test procedures shall conform to ASTM D 5055, Sections 6.2.4 through 6.2.11.

6.3.2 *Valid Test* - All tests exhibiting shear failure are considered valid. Tests exhibiting non-shear failures may be considered valid with the exception that an optional replacement test of the same prefabricated wood I-joist depth and series is permitted. If a replacement test is taken, it shall be of the same depth and series and taken from production just prior to or just after the initial specimen, and the original test result shall be excluded from further consideration.

6.3.3 *Joist Series Group Database* - A database of normalized test results shall be established for each joist series group. As a minimum, each database shall contain the following information for each valid test: date of production and shift, joist series, production line, web supplier, prefabricated wood I-joist depth and normalized test result.

6.3.4 *Normalized Population Mean (NPM)* - The normalized population mean, as defined below, for each joist series group is based on the number of specimens tested and the test data variability. The NPM shall be reassessed at the frequency specified for periodic reevaluation as per Section 11 of ASTM D 5055. For a new product series the initial NPM shall be based on the results of the qualification tests as required by ASTM D 5055, Section 6.2.

$$NPM = 2.37/(1 - KV)$$

where,

K = factor for one-sided 95% tolerance limit with 75% confidence for a normal distribution. Values for this factor are given in Appendix X4, Table X4.3 of ASTM D 5055. K is based on the number of valid test entries (N) in the database up to the maximum time period of the last 12 months.

V = coefficient of variation of the normalized test results in the database over the same time period that N (above) is based on.

6.3.5 *Low Production Volume Requirements* - At the end of each month the number of tests performed per joist series group during the last two months shall be counted. If the number of tests is less than 16, the test frequency of Section 6.4.1 shall be doubled until a total of 16 tests (including the tests of the previous two months) are attained.

6.4 Individual Test Requirements

6.4.1 *Test Frequency* - As a minimum, there shall be at least one shear test specimen randomly selected from each production line and tested for every 25,000 feet (7600 m) or two (2) hours of production (whichever occurs first) and for each change of prefabricated wood I-joist depth or series. The prefabricated wood I-joist depth or series change specimen must be taken immediately after a change and the production lineal footage count and the two-hour time period shall be restarted.

NOTE: *The sample rate shall be doubled at the start of initial production and any time that production is stopped for an extended length of time.*

6.4.2 *Individual Test Limit (ITL)* - The ITL shall be:

$ITL = NPM(1 - K_1V)$

where,

NPM and V are as defined in Section 6.3.4 and,

$K_1 = 1.645$

6.4.3 If the NTR is equal to or greater than the ITL the NTR is added to the database and no further action is required. If the NTR is less than the ITL, all production since the last passing test shall be placed on hold and an immediate retest is required.

6.5 Retest Requirements

6.5.1 An immediate single retest is required for every specimen whose NTR is less than the required ITL. The retest specimen shall be of the same depth and series and taken from production just prior to or just after the initial specimen. The cause of the failure shall be identified (when possible) and all single test failures and subsequent retests shall be documented in the monthly report required by Section 5.3.

6.5.2 *Retest Limit (RTL)* - The RTL shall be:

$RTL = NPM(1 - K_2V)$

where,

NPM and V are as defined in Section 6.3.4 and,

$K_2 = 1.0$

6.5.3 If the normalized retest result is equal to or greater than the RTL the NTR is added to the database and no further action is required. If the normalized retest result is less than the RTL, all production since the last passing test shall be placed on hold. The production between the original failing individual test and the subsequent failing retest shall rejected and final testing shall be instituted.

6.6 Final Testing

6.6.1 The previously failing tests shall be evaluated and the cause of the problem determined. Corrective action taken and all suspect production shall be placed on hold.

6.6.2 Five (5) test specimens each shall be selected from product manufactured just prior to and just after the rejected product. These ten specimens shall be tested in accordance with Section 6.3.1. This sampling should be conducted in an effort to bracket and separate all of the defective product from normal production.

6.6.3 If all ten of the selected specimen test results are equal to or greater than the ITL, and the average is equal to or greater than the RTL, the test results shall be documented and reported in the monthly report. The lowest test result from the ten specimen-passing sample is added to the database. If any of the selected test specimens fail at less than the ITL, or if the average is less than the RTL, the cause of the problem shall be reevaluated and corrective action

shall be taken. The extent of the investigation to isolate the defective product shall be expanded based on the above reevaluation. The bracketed material identified as not having met the above criteria shall be downgraded or rejected. Additional sampling and testing as described in Sections 6.6.1 and 6.6.2 shall be continued in this manner until all defective product has been identified and properly disposed of in accordance with Section 6.8.

6.7 Trend Analysis

6.7.1 Trends in averaged and/or near minimum NTR's shall be monitored and corrective action taken when appropriate. Over time (6-12 months) the average NTR is expected to be very close to the established NPM. Over shorter time periods (2-5 day's) the averaged NTR should not be significantly less than the NPM. Engineering judgment is necessary to establish requirements appropriate to a given product and process.

Note: - *Statistical process control textbooks discuss various trend analysis techniques. Examples of trend analysis techniques used by some prefabricated wood I-joist manufacturers include a floating mean or floating 5th percentiles, computed from normalized test results.*

6.8 Product Disposition

6.8.1 Only production, which meets or exceeds the requirements of Section 6 may be released for shipment.

6.8.2 All down graded or reject material shall be separated from all qualifying production and shall be clearly marked as reject or down graded. A professional engineer and the qualified agency shall approve the disposition of down graded structural material. Appropriate records regarding the use and disposition of all down graded and reject material shall be kept as part of the quality assurance records and reported in the next monthly report.

7. End Joint Testing

7.1 Scope

Requirements are specified for end joint tension and delamination testing and are applicable to full cross-section end joints in both lumber and structural composite lumber (SCL) flanges. Requirements for flange face or edge joints and partial cross section end joints are beyond the scope of these guidelines. Section 7 discusses the mandatory components of an effective end jointing process control program and defines the final end joint tension and delamination test requirements for flange quality assurance testing. Individual test, retest and final test requirements are detailed. Additionally, requirements for establishing an end joint test database and recommendations regarding trend analysis are provided.

The provisions of Section 7 are applicable to end joints fabricated by the prefabricated wood I-joist manufacturer or an outside supplier, using standard or short length lumber or SCL, and where the allowable moment is determined analytically or empirically. Further, the provisions outlined in this section use as a basis those outlined in ASTM D5055 and NLGA SPS 4. Additional requirements for end jointed lumber or SCL obtained from an external supplier are

detailed in Section 7.9. Additional requirements for end joints in non-standard (i.e. short) length lumber or SCL are detailed in Section 7.10.

7.2 Definitions

7.2.1 *End Joint Tension Failure* - A failure of the flange, under tension, associated with the end joint. For purposes of evaluating end joint capacity, tensile failure away from the end joint need not be considered.

7.2.2 *Test Result (TR)* - The tension stress producing failure in an end joint test.

7.2.3 *Normalized Test Result (NTR)* - The NTR shall be:

NTR = TR/P

where,

P = Flange tensile design value (working stress design), as defined by Section 3.2.2 of ASTM D 5055.

Note*: The allowable flange tension stress, for products utilizing the analytical moment method, is determined from Section 6.3.1 of ASTM D 5055. The allowable flange tension stress, for products utilizing the empirical moment method, shall be back calculated from the assigned design moment capacity using the transformed net section approach.*

7.2.4 *Flange Grade* - Includes all finished flanges with the same grade rule basis, allowable tension stress and MOE.

7.2.5 *End Jointed Flange Series Group* - Includes all end jointed flanges of the same flange grade, species groups with comparable bonding characteristics (see AITC 200, Section 5.2.2.2 or WWPA C/QC 101), and nominal cross sectional dimensions, end jointed on the same production line. Test data obtained from different sizes may be combined provided a statistical analysis, such as a T-test, is conducted.

7.2.6 *Shift* - For the purposes of this section a shift is the equivalent of 8 to 12 hours of production.

7.2.7 *Short Length Flange Material* - Short length flange stock is defined as material less than eight feet in length, prior to trimming for clear wood at the joint.

7.3 General Requirements

7.3.1 *Test Specimens* – End joint delamination and full size flange end joint tension tests are required. End joint tension tests shall be conducted to failure on the finished flange size. The end joint tension test set up and procedures shall conform to the intent of Section 6.4 of ASTM D 5055 or Section 9 of NLGA SPS 4. The delamination test set up and procedures shall conform to AITC Test T110 - Cyclic Delamination Test, or as an alternate Section 9.2.2 of NLGA SPS 1.

7.3.2 *Valid Tension Test* - All tension tests exhibiting an end joint tension failure are considered valid. Tension tests exhibiting failures primarily away from the end joint

(mode 5 or mode 6 failures, as defined in Table E of Section 5.2.5.4 of AITC 200) are considered valid with the exception that an optional replacement test of the same flange size and grade, is permitted. If a replacement test is taken the original test result shall be excluded from further consideration.

7.3.3 *End Jointed Flange Series Group Database* - A database of normalized test results shall be established for each end jointed flange series group. As a minimum, each database shall contain the following information for each valid test: date of production and shift, production line, flange size, flange grade, flange supplier and normalized test result or percent delamination.

7.3.4 *Normalized Population Mean (NPM)* - The normalized population mean, as defined below, for each end jointed flange series group is based on the number of specimens tested and the test data variability. The NPM shall be reassessed at the frequency specified for periodic reevaluation as per Section 11 of ASTM D 5055. For a new product series the initial NPM shall be based on the results of the qualification tests as required by ASTM D 5055, Section 6.4 or NLGA SPS 4, Section 9.

$$NPM = 2.1/(1 - KV)$$

where,

K = factor for one-sided 95% tolerance limit with 75% confidence for a normal distribution. Values for this factor are given in Appendix X4, Table X4.3 of ASTM D 5055. K is based on the number of valid test entries (N), for the flange series group under consideration, up to the maximum time period of the last 12 months.

V = coefficient of variation of the normalized test results in the database over the same time period upon which N (above) is based.

7.3.5 *Low Production Volume Requirements* - At the end of each month the number of tests performed per end joint flange series group during the last two months shall be checked. If the number of tests is less than 16, the specified test frequency in 7.4.1 shall be doubled until a total of 16 tests are obtained for the two-month period.

7.3.6 *Process Control Considerations* - Section 1.0 regarding overall scope discusses the importance and necessity of appropriate process controls. This section outlines basic process control considerations that provide the judgmental basis for the end joint test frequencies and data analysis criteria below.

Note: *The following list of process controls is not all-inclusive. It is the sole responsibility of the manufacturer to determine the full set of process controls required for their manufacturing facility to produce end joints, which conform to the intent of this document.*

7.3.6.1 The plant manufacturing standard shall specify knot, slope of grain and other defect restrictions in the vicinity of the end joint.

Note: - *ANSI A190.1, Section 4.5.2.3 provides a criteria for glued-laminated timber tension members.*

7.3.6.2 The plant manufacturing standard shall specify process control checks for end joint quality.

Note: - *AITC Test T105 - Diagnostic Tests for Finger Joint Quality is utilized by the glued-laminated timber industry to evaluate end joint quality.*

7.3.6.3 Each end joint, cured using radio frequency (or similar methods), shall be proof loaded in either bending or tension. When bending proof loading is utilized, a double bend proof loader (i.e. stresses either both faces or both edges of the end joint in tension) is strongly recommended. Proof load levels shall be agreed upon between the manufacturer and qualified agency and shall consider the specific process parameters for the end joint line. Flanges which fail in the proof loading process shall have all end joints removed prior to re-end jointing.

Exception: Flanges need not have all end joints removed if all of the following conditions are met: (1) the proof load shall be tension only; (2) the minimum target proof load level shall be 1.5 times the allowable design stress and shall not be adjusted by a cure factor; (3) the closest end joint to the failed end joint is tension tested per Section 7.3.1 and (4) after re-end jointing the entire flange shall be proof loaded again to the minimum target proof load specified in (2) above. All end joints shall be removed if the flange fails during the second proof loading.

Flange proof loading does not provide verification of final design strength and therefore does not reduce the full size destructive end joint tension test requirements of Sections 7.4, 7.5 and 7.6.

7.4 Individual Test Requirements

7.4.1 *Test Frequency* - As a minimum, there shall be at least one destructive end joint tension test specimen randomly selected from production and tested for every one (1) hour of production and at each change of cutter head. The cutter head change specimen must be taken immediately after the change and the 1-hour time period may be restarted.

NOTE: *The sample rate shall be doubled at the start of initial production and any time that production is stopped for an extended length of time.*

7.4.2 *Individual Test Limits* - The ITL shall be:

$$ITL = NPM(1 - K_1V)$$

where,

NPM and V are as defined in Section 7.3.4 and,

$K_1 = 1.645$

7.4.3 If the NTR is equal to or greater than the ITL the NTR is added to the database and no further action is required. If the NTR is less than the ITL, all production since the last passing test shall be placed on hold and an immediate retest is required.

7.5 Retest Requirements

7.5.1 An immediate single retest is required for every specimen whose NTR is less than the required ITL. The retest specimen shall be of the same size, grade and production run as the initial specimen. The cause of the failure shall be identified (when possible) and all single test failures and subsequent retests shall be documented in the monthly report required by Section 5.3.

7.5.2 *Retest Limit (RTL)* - The RTL shall be:

$$RTL = NPM(1 - K_2V)$$

where,

NPM and V are as defined in Section 7.3.4 and,

$K_2 = 1.0$

7.5.3 If the normalized retest result is equal to or greater than the RTL, the NTR is added to the appropriate end jointed flange series group database and no further action is required. If the normalized retest result is less than the required RTL, all production since the last passing test shall be placed on hold. The production between the original failing individual test and the subsequent failing retest shall be rejected and final testing shall be instituted.

7.6 Final Testing

7.6.1 The previously failing tests shall be evaluated and the cause of the problem determined. Corrective action shall be taken and all suspect production shall be placed on hold.

7.6.2 Five (5) test specimens each shall be selected from product manufactured just prior to and just after the down graded or rejected product. These ten specimens shall be tested in accordance with Section 7.3.1. This sampling should be conducted in an effort to bracket and separate all of the defective product from normal production.

7.6.3 If all ten of the selected test specimens fail at equal to or greater than the ITL and the average is equal to or greater than the RTL, the test results shall be documented and reported in the monthly report. The lowest normalized test result from the ten piece-passing sample is added to the appropriate database. If any of the selected test specimens fail at less than the ITL, or if the average is less than the RTL, the cause of the problem shall be reevaluated and corrective action shall be taken. The extent of the investigation to isolate the defective product shall be expanded based on the above reevaluation. The bracketed material identified as not having met the above criteria shall be downgraded or rejected. Additional sampling and testing as described in Sections 7.6.1 and 7.6.2 shall be continued until all defective product has been identified and properly disposed of in accordance with Section 7.11.

7.7 Trend Analysis

7.7.1 Trends in averaged and/or near minimum NTR's shall be monitored and corrective action taken when appropriate. Over time (6-12 months) the average NTR is expected

to be very close to the established NPM. Occasionally, over shorter time periods (2-5 day's) the average NTR should not be significantly less than the NPM. Engineering judgment is necessary to establish requirements appropriate to a given product and process.

Note: - *Statistical process control textbooks discuss various trend analysis techniques. Examples of trend analysis techniques used by some prefabricated wood I-joist manufacturers include a floating mean or floating 5th percentiles, computed from normalized test results.*

7.8 End Joint Delamination Test Requirements

7.8.1 *Test Frequency* - As a minimum, there shall be at least one delamination test specimen randomly selected from production and tested for every shift of production.

7.8.2 *Individual Test Limits* - The delamination individual test limit (ITL) for each test shall be 5%. If the delamination test result is equal to or lesser than the ITL the test result is added to the database and no further action is required. If the delamination test result is greater than the ITL, all production since the last passing test shall be placed on hold and an immediate retest is required for the failing test. The cause of the failure shall be identified (when possible) and all individual test failures and subsequent retests shall be documented in the monthly report required by Section 5.3.

7.8.3 *Retest Requirements* - An immediate five-specimen delamination retest is required for every specimen whose test result is greater than the required ITL. The retest specimens shall be of the same size, grade and production run as the initial specimen. If all retest results are equal to or less than the required ITL the original individual test result is added to the database and no further action is required. If any retest result is greater than the required ITL, all production since the last passing test shall remain on hold. The production between the original failing individual test and the subsequent failing retest shall be rejected and final testing shall be instituted.

7.8.4 *Final Testing* - The previously failing delamination tests shall be evaluated. The cause of the problem shall be determined, corrective action taken and all suspect production shall be placed on hold. Five (5) test specimens each shall be selected at random from product manufactured just prior to and just after the rejected product. These ten specimens shall be tested in accordance with Section 7.3.1. This sampling should be conducted in an effort to bracket and separate all of the defective product from normal product. If all ten of the selected specimens fail at equal to or less than the ITL the test results shall be documented and reported in the monthly report and only the highest test result from the ten piece passing sample is added to the database. If any of the ten selected specimens fail at greater than the ITL, the cause of the problem shall be reevaluated, corrective action taken and the extent of defective product shall be expanded based on the above evaluation. Additional sampling and delamination testing per this Section shall be instituted and the qualified agency shall be notified.

7.9 End Jointed Flanges Obtained from an External Supplier

7.9.1 *General* - This section is applicable to lumber or SCL, used as a prefabricated wood I-joist flange, end jointed by a supplier external to the prefabricated wood I-joist manufacturing facility. End jointed flanges obtained from an external supplier shall be qualified in accordance with Section 6.4 of ASTM D 5055 or Section 9 of NLGA SPS 4. The prefabricated wood I-joist manufacturer shall keep copies of qualification test records on file. All end joint quality assurance provisions specified in Section 7 apply separately to each external end joint production line. The prefabricated wood I-joist manufacturer shall specify the required allowable tension stress to the external end joint supplier. The prefabricated wood I-joist manufacturer shall obtain and keep on file monthly records from the outside supplier that demonstrate compliance with Section 7. The monthly summary report required in Section 5.3 shall include copies of pertinent records from each external supplier and an analysis that demonstrates compliance with the requirements of this section.

7.9.2 *Independent Inspection* - Quality assurance audits for outside suppliers shall be performed a minimum of 12 times per year as required per Section 3 of this document. The prefabricated wood I-joist manufacturer shall approve the end jointed flange supplier's qualified agency.

7.9.3 *Confirmation Testing at the Prefabricated Wood I-Joist Plant* - The prefabricated wood I-joist manufacturer shall maintain a confirmation test program for each external supplier. The confirmation test program details shall be determined by the prefabricated wood I-joist manufacturer and their qualified agency and documented in the prefabricated wood I-joist manufacturer's manufacturing standard. Confirmation testing is permitted to utilize either full scale end jointed flange tension testing or the full scale empirical bending test on the finished prefabricated wood I-joist.

7.10 Provisions for Short Length End Jointed Lumber or SCL

The minimum distance permitted between end joints and the maximum number of end joints permitted in any 8 foot length of flange shall be documented in the prefabricated wood I-joist manufacturer's and the external end jointed flange supplier's (if applicable) manufacturing standards. The end joint tension test set up and procedures shall conform to the intent of Sections 6.3.1.3 and 6.3.1.4 of ASTM D 5055 or Section 9 of NLGA SPS 4. Each test specimen shall either contain the maximum number of end joints permitted in the prefabricated wood I-joist manufacturer's and the external end jointed flange supplier's (if applicable) manufacturing standards, or each test result shall be appropriately adjusted for the actual number of end joints in the test specimen.

7.11 Product Disposition

7.11.1 Only production, which meets or exceeds the requirements of Section 7 may be released for use as a prefabricated wood I-joist flange.

7.11.2 All down graded or reject material shall be separated from all qualifying production and shall be clearly marked as reject or down graded. A qualified professional

engineer and the qualified agency shall approve the disposition of down graded material. Appropriate records regarding the use and disposition of all down graded and reject material shall be kept as part of the quality assurance records and reported in the next monthly report.

8. Analytical Moment Flange Tension Testing

8.1 Scope

This section defines a minimum level of quality assurance testing for materials used for prefabricated wood I-joist flanges qualified under the analytical moment method. Typically testing is only required when using allowable stresses greater than code assigned "book" values. Lumber or SCL flanges containing end joints shall meet the strength and bond quality provisions of Section 7.0. Individual test, retest and final test requirements are detailed. Additionally, requirements for establishing a flange test database and recommendations regarding trend analysis are provided.

8.1.1 *SCL* - SCL flanges are assumed to have code assigned design properties determined in accordance with ASTM D 5456. Therefore further testing to substantiate design values is not required. These guidelines do not contain adequate test frequencies for the flange tension testing of SCL which does not have code assigned design properties. Therefore modification of code assigned SCL design properties, outside the code evaluation process, is beyond the scope of this document.

8.1.2 *Lumber with NDS published Assigned Design Properties or CAN/CSA-O86 Specified Strengths, Used without Increases in Original Assigned Stresses* - Flange testing to substantiate code assigned "book" values is not required. Ripping wide dimension lumber to narrower widths is permitted if an approved lumber grader regrades the ripped flanges.

8.1.3 *Lumber NDS published Assigned Design Properties or CAN/CSA-O86 Specified Strengths, Sorted to a Higher Grade* - Sorting lumber to higher recognized grades is permitted only if it is regraded by an approved lumber grader. Ripping wide dimension lumber to narrower widths is permitted if an approved lumber grader regrades the ripped flanges.

8.1.4 *Lumber flanges with NDS published Assigned Design Properties or CAN/CSA-O86 Specified Strengths, Used with Proprietary Increases in Original Assigned Tension Values* - Proprietary rules, which provide the basis of increased stresses, shall be documented in the manufacturing standard. Tension testing noted below is required to substantiate increased stresses. Ripping wide dimension lumber to narrower widths is permitted if final flange widths are regraded to the proprietary grade rules by an approved lumber grader prior to tension testing.

8.1.5 *Lumber Flanges without NDS published Assigned Design Properties or CAN/CSA-O86 Specified Strengths,* - These guidelines do not contain adequate test frequencies for materials without assigned properties and as such those materials are beyond the scope of this document.

8.2 Definitions

8.2.1 *Flange Tension Failure* - A failure of the flange, under tension.

8.2.2 *Test Result (TR)* - The tension stress producing failure in a flange tension test.

8.2.3 *Normalized Test Result (NTR)* - The NTR shall be:

NTR = TR/P

where,

P = Allowable tension stress (working stress design), as defined by Section 3.2.2 of ASTM D 5055.

8.2.4 *Flange Grade* - Includes all finished flanges with the same "grade rule basis", allowable tension stress and MOE.

8.2.5 *Flange Series Group* - Includes all flanges of the same grade and nominal cross sectional dimensions. Test data obtained from different sizes may be combined provided a statistical analysis, such as a T-test, is conducted.

8.2.6 *Shift* - For the purposes of this section a shift is the equivalent of 8 to 12 hours of production.

8.3 General Requirements

8.3.1 *Test Specimens* - Tension tests shall be conducted to failure on the finished flange size. The flange tension test set up and procedures shall conform to the intent of Section 6.3.1.3 of ASTM D 5055 or Section 9 of NLGA SPS 4.

8.3.2 *Valid Tension Test* - All flange tension tests exhibiting a tensile failure are considered valid.

8.3.3 *Flange Series Group Database* - A database of normalized test results shall be established for each flange series group. As a minimum, each database shall contain the following information for each valid test: test date, production line, flange size and grade, flange supplier and normalized test result.

8.3.4 *Normalized Population Mean (NPM)* - The normalized population mean, as defined below, for each flange series group is based on the number of specimens tested and the test data variability. The NPM shall be reassessed at the frequency specified for periodic reevaluation as per Section 11 of ASTM D 5055 or Sections 13.5 through 13.8 of NLGA SPS 4. For a new product series the initial NPM shall be based on the results of the qualification tests as required by ASTM D 5055, Section 6.3 or NLGA SPS 4, Section 9.

NPM = 2.1/ (1 - KV)

where,

K = factor for one-sided 95% tolerance limit with 75% confidence for a normal distribution. Values for this factor are given in Appendix X4, Table X4.3 of

ASTM D 5055. K is based on the number of valid test entries (N), for the flange series group under consideration, up to the maximum time period of the last 12 months.

V = coefficient of variation of the normalized test results in the database over the same time period upon which N (above) is based.

8.3.5 *Low Production Volume Requirements* - At the end of each month the number of tests performed per flange series group during the last two months shall be checked. If the number of tests is less than 16, the specified test frequency in 8.4.1 shall be doubled until a total of 16 tests are obtained for the two-month period.

8.3.6 *Manufacturing Standard* - The plant manufacturing standard shall document knot, slope of grain and other defect restrictions necessary to maintain proprietary grade rules.

8.4 Individual Tension Test Requirements

8.4.1 *Test Frequency* - As a minimum, there shall be at least one destructive flange tension test specimen randomly selected from production and tested for every two-(2) hours of flange grading.

NOTE: *The sample rate shall be doubled at the start of initial production and any time that production is stopped for an extended length of time.*

8.4.2 *Individual Test Limit (ITL)* - The ITL shall be:

$$ITL = NPM (1 - K_1V)$$

where,

NPM and V are as defined in Section 8.3.4 and,

$K_1 = 1.645$

8.4.3 If the NTR is equal to or greater than the ITL the NTR is added to the database and no further action is required. If the NTR is less than the ITL, all production since the last passing test shall be placed on hold and an immediate retest is required for the failing test.

8.5 Retest Requirements

8.5.1 An immediate single tension retest is required for every specimen whose NTR is less than the required ITL. The retest specimen shall be of the same size, grade and production run as the initial specimen. The cause of the failure shall be identified (when possible) and all single test failures and subsequent retests shall be documented in the monthly report required by Section 5.3.

8.5.2 *Retest Limit (RTL)* - The RTL shall be:

$$RTL = NPM (1 - K_2V)$$

where,

NPM and V are as defined in Section 8.3.4 and,

$K_2 = 1.0$

8.5.3 If the normalized retest result is equal to or greater than the required RTL, the original single test result is added to the database and no further action is required. If the retest result is less than the required RTL, all production since the last passing test shall remain on hold. The production between the original failing individual test and the subsequent failing retest shall be rejected and final testing shall be instituted.

8.6 Final Tension Testing

8.6.1 The previously failing tests shall be evaluated and the cause of the problem determined. Corrective action shall be taken and all suspect production shall be placed on hold.

8.6.2 Five (5) test specimens each shall be selected at random from product manufactured just prior to and just after the down graded or rejected product. These ten specimens shall be tested in accordance with Section 8.3.1. This sampling should be conducted in an effort to bracket and separate all of the defective product from normal production.

8.6.3 If all ten of the selected test specimens fail at equal to or greater than the ITL and the average is equal to or greater than the RTL, the test results shall be documented and reported in the monthly report. The lowest normalized test result from the ten piece-passing sample is added to the appropriate database. If any of the selected test specimens fail at less than the ITL, or if the average is less than the RTL, the cause of the problem shall be reevaluated and corrective action shall be taken. The extent of the investigation to isolate the defective product shall be expanded based on the above reevaluation. The bracketed material identified as not having met the above criteria shall be downgraded or rejected. Additional sampling and testing as described in Sections 8.6.1 and 8.6.2 shall be continued in this manner until all defective product has been identified and properly disposed of in accordance with Section 8.9.

8.7 Trend Analysis

8.7.1 Trends in averaged and/or near minimum NTR's shall be monitored and corrective action taken when appropriate. Over time (6-12 months) the average NTR is expected to be very close to the established NPM. Over shorter time periods (2-5 day's) the average NTR should not be significantly less than the NPM. Engineering judgment is necessary to establish requirements appropriate to a given product and process.

Note: - *Statistical process control textbooks discuss various trend analysis techniques. Examples of trend analysis techniques used by some prefabricated wood I-joist manufacturers include a floating mean or floating 5th percentile, computed from normalized test results.*

8.8 Flanges Obtained from an External Supplier

8.8.1 *General* - This section is applicable to lumber or SCL, used in a prefabricated wood I-joist flange, provided by a supplier external to the prefabricated wood I-joist manufacturing facility. Flanges obtained from an external supplier shall be qualified in accordance with Section 6.3.1 of ASTM D 5055 or Section 9 of NLGA SPS 4. The prefabricated wood I-joist manufacturer shall keep copies of qualification test records on file. All flange quality assurance provisions specified in Section 8 apply separately to each external flange supplier. The prefabricated wood I-joist manufacturer shall specify, to the external flange supplier, the required allowable tension stress. The prefabricated wood I-joist manufacturer shall obtain and keep on file monthly records from the external supplier that demonstrates compliance with Section 8. The monthly summary report required in Section 5.3 shall include copies of pertinent records from each outside supplier and an analysis that demonstrates compliance with the requirements of this section.

8.8.2 *Independent Inspection* - Quality assurance audits for outside suppliers shall be performed a minimum of 12 times per year as required per Section 3 of this document. The prefabricated wood I-joist manufacturer shall approve the flange supplier's qualified agency.

8.8.3 *Confirmation Testing at the Prefabricated Wood I-Joist Plant* - The prefabricated wood I-joist manufacturer shall maintain a confirmation test program for each external supplier. The confirmation test program details shall be determined by the prefabricated wood I-joist manufacturer and their qualified agency and documented in the prefabricated wood I-joist manufacturer's manufacturing standard. Confirmation testing shall utilize full-scale flange tension testing in accordance with Section 8.3.1.

8.9 Product Disposition

8.9.1 Only production, which meets or exceeds the requirements of Section 8.0 may be released for use as a prefabricated wood I-joist flange.

8.9.2 All down graded or reject material shall be separated from all qualifying production and shall be clearly marked as reject or down graded. A professional engineer and the qualified agency shall approve the disposition of down graded structural material. Appropriate records regarding the use and disposition of all down graded and reject material shall be kept as part of the quality assurance records and reported in the next monthly report.

9. Empirical Moment Method Testing

9.1 Scope

This section defines the minimum requirements of quality control bending moment testing for prefabricated wood I-joists which base the assigned moment capacity on the empirical moment method (Section 6.3.3 of ASTM D 5055). Individual test, retest and final test requirements are detailed. Additionally, requirements for establishing a moment test database and recommendations regarding trend analysis are provided.

9.1.1 *SCL Flanges* - SCL flanges are assumed to have code assigned design properties determined in accordance with ASTM D 5456. These guidelines do not contain adequate bending moment test frequencies for prefabricated wood I-joists which use SCL flanges that do not have code approved design properties. The moment testing described in this Section is required to substantiate the prefabricated wood I-joist moment capacity.

9.1.2 *Lumber flanges with NDS published Assigned Design Properties or CAN/CSA-O86 Specified Strengths, Used with Proprietary Increases in Original Assigned Tension Values* - Proprietary rules, which provide the basis of increased stresses, shall be documented in the manufacturing standard. The moment required in Section 9.4 is required to substantiate increased stresses. Ripping wide dimension lumber to narrower widths is permitted if final flange widths are regraded to the proprietary grade rules, by an approved grader prior to tension testing.

9.1.3 *Lumber Flanges without NDS published Assigned Design Properties or CAN/CSA-O86 Specified Strengths,* - These guidelines do not contain adequate test frequencies for materials without assigned properties and as such those materials are beyond the scope of this document.

9.2 Definitions

9.2.1 *Moment Failure* – A failure of the prefabricated wood I-joist, in a long span bending moment test, associated with the flange material. Flange failure can occur in tension, compression or buckling.

Note: *For more information regarding common prefabricated wood I-joist moment failure modes see Appendix X5 of ASTM D 5055.*

9.2.2 *Test Result (TR)* - The maximum applied moment producing a moment failure.

9.2.3 *Normalized Test Result (NTR)* – The NTR shall be:

NTR = TR/P

where,

P = moment design value (working stress design), as defined by Section 3.2.2 of ASTM D 5055.

9.2.4 *Joist Type* – Includes all prefabricated wood I-joists of the same depth, which have the same flange grade, species, size and orientation, web type thickness and grade, web to web joint, web to flange joint and produced on the same production line.

9.2.5 *Shift* – For the purposes of this section a shift is the equivalent of 8 to 12 hours of continuous production.

9.3 General Requirements

9.3.1 *Quality Assurance Moment Test* – The quality assurance moment test set up and test procedures shall conform to Sections 6.3.3 and 9.5.3.5 of ASTM D 5055.

9.3.2 *Valid Test* – All tests exhibiting moment failures are considered valid. Tests exhibiting non-moment failures may be considered valid with the exception that an optional replacement test of the same joist type taken within the same two-hour period as specified in Section 9.4.1 is permitted. If a replacement test is taken the original test result shall be excluded from further consideration.

9.3.3 *Joist Type Database* – A database of normalized test results shall be established for each joist type. As a minimum, each database shall contain the following information for each valid test: date of production and shift, joist type, production line, web supplier, flange supplier, and normalized test result. Normalized test results for different prefabricated wood I-joist depths (minimum of four are required) which have the same flange grade, species, size and orientation, the same web type, thickness and grade and the same web to web and web to flange joint, may be combined in the same joist type database, provided the assigned moment capacities are determined in accordance with the linear regression and coefficient of determination (r^2) requirements of Section 6.3.3.5 of ASTM D 5055.

9.3.4 *Normalized Population Mean (NPM)* - The normalized population mean, as defined below, for each joist type is based on the number of specimens tested and the test data variability. The NPM shall be reassessed at the frequency specified for periodic reevaluation as per Section 11 of ASTM D 5055. For a new joist type the initial NPM shall be based on the results of the qualification tests as required by ASTM D 5055, Section 6.3.3.

$$NPM = 2.1/(1 - KV)$$

where,

K = factor for one-sided 95% tolerance limit with 75% confidence for a normal distribution. Values for this factor are given in Appendix X4, Table X4.3 of ASTM D 5055. K is based on the number of valid test entries (N) in the database up to the maximum time period of the last 12 months.

V = coefficient of variation of the normalized test results in the database over the same time period that N (above) is based on.

Note: - *For future Commentary.*

9.3.5 *Low Production Volume Requirements* - At the end of each month the number of tests performed and recorded in each joist type database during the last two months shall be counted. If the number of tests is less than 16, the test frequency of Section 9.4.1 shall be doubled until a total of 16 tests (including the tests of the previous two months) are attained.

9.4 Individual Test Requirements

9.4.1 *Test Frequency* – As a minimum there shall be at least one moment test specimen of each joist type randomly selected from each production line and tested for every 25,000 feet (7600 m) or two (2) hours of production (whichever occurs first) and for each change of joist type. The joist type change specimen must be taken immediately after a change and the production lineal footage count and the two-hour time period shall be restarted.

NOTE: *The sample rate shall be doubled at the start of initial production and any time that production is stopped for an extended length of time.*

9.4.2 *Individual Test Limit (ITL)* – The ITL for each normalized test result (NTR) shall be determined by:

$$ITL = NPM(1- K_1V)$$

where,

NPM and V are as defined in Section 9.3.4 and,

$K_1 = 1.645$

9.4.3 If the NTR is equal to or greater than the ITL, the NTR is added to the database and no further action is required. If the NTR is less than the ITL, all production since the last passing test shall be placed on hold and an immediate retest is required.

9.5 Retest Requirements

9.5.1 An immediate single retest is required for every specimen whose NTR is less than the required ITL. The retest specimen shall be of the same joist type, flange supplier and taken from production within two hours prior to or after production of the initial specimen. The cause of the failure shall be identified (when possible) and all single test failures and subsequent retests shall be documented in the monthly report required by Section 5.3.

9.5.2 *Retest Limit (RTL)* - The RTL shall be:

$RTL = NPM(1 - K_2V)$

where,

NPM and V are as defined in Section 9.3.4 and,

$K_2 = 1.0$

Note: - *For future Commentary.*

9.5.3 If the NTR is equal to or greater than the RTL, the NTR is added to the appropriate joist type database and no further action is required. If the normalized retest result is less than the RTL, all production since the last passing test shall remain on hold. The production between the original failing individual test and the subsequent failing retest shall rejected and final testing shall be instituted.

9.6 Final Testing

9.6.1 The previously failing tests shall be evaluated and the cause of the problem determined. Corrective action shall be taken and all suspect production shall be placed on hold.

9.6.2 Five (5) test specimens each shall be selected from product manufactured just prior to and just after the rejected product. These ten specimens shall be tested in accordance with Section 9.3.1. This sampling should be conducted in an effort to bracket and separate all of the defective product from normal product.

9.6.3 If all ten of the selected test specimens fail at equal to or greater than the ITL and the average is equal to or greater than the RTL, the test results shall be documented and reported in the monthly report. The lowest normalized test result from the ten piece-passing sample is added to the appropriate database. If any of the selected test specimens fail at less than the ITL, or if the average is less than the RTL, the cause of the problem shall be reevaluated and corrective action shall be taken. The extent of the investigation to isolate the defective product shall be expanded based on the above reevaluation.. The bracketed material identified as not having met the above criteria shall be downgraded or rejected. Additional sampling and testing per Section 9.6 shall be continued in this manner until all defective product has been identified and properly disposed of in accordance with Section 9.8

9.7 Trend Analysis

9.7.1 Trends in averaged and/or near minimum NTR's shall be monitored and corrective action taken when appropriate. Over time (6-12 months) the average NTR is expected to be very close to the established NPM. Over shorter time periods (2-5 day's) the average NTR should not be significantly less than the NPM. Engineering judgment is necessary to establish requirements appropriate to a given product and process.

Note: - *Statistical process control textbooks discuss various trend analysis techniques. Examples of trend analysis techniques used by some prefabricated wood I-joist manufacturers include a floating mean or floating 5th percentile, computed from normalized test results.*

9.8 Product Disposition

9.8.1 Only prefabricated wood I-joist production, which meets or exceeds the requirements of Section 9 may be released for shipment.

9.8.2 All down graded or reject material shall be separated from all qualifying production and shall be clearly marked as reject or down graded. A professional engineer and the qualified agency shall approve the disposition of down graded structural material. Appropriate records regarding the use and disposition of all down graded and reject material shall be kept as part of the quality assurance records and reported in the next monthly report.

10. Adhesive Requirements

10.1 General

The adhesives shall be evaluated by the qualified agency for the intended use in the manufacturing process for flange end joints where applicable, as well as web-to-web and web-to-flange bonding. As a minimum the adhesive approval process shall include requirements for both the adhesive manufacturer and the prefabricated wood I-joist manufacturer, for each adhesive type and wood species groups with comparable bonding characteristics (see AITC 200, Section 5.2.2.2 or WWPA C/QC 101) to be used in the prefabricated wood I-joist production. The adhesive manufacturer shall provide confirmation for each adhesive lot that the adhesive is in conformance with ASTM D 2559 (wet-use) or CSA O112 Series-M and other requirements when specified by the prefabricated wood I-joist manufacturer. Adhesives not applicable to these Standards may be used provided they have demonstrated that they provide equivalent performance. The adhesive approval process and requirements and all approved adhesives shall be documented in the prefabricated wood I-joist manufacturer's manufacturing standard.

10.2 Adhesive Quality Assurance

The prefabricated wood I-joist manufacturer's manufacturing standard shall document all required adhesive specifications and all quality assurance testing required for each new lot shipment of adhesive components (typically matched lots of resin and catalyst). When a new lot of either the resin or catalyst component is to be used with a previously tested

component, the new combination shall be tested in accordance with the requirements of the prefabricated wood I-joist manufacturer's manufacturing standard. No lot shipment of adhesive component shall be released for use in production until all required tests have been successfully conducted and all required documentation has been checked for conformance with all stated requirements.

11. Web Material Requirements

11.1 General

Web stock materials typically conform to sheathing product standards PS-1, PS-2 or CAN/CSA O325.0. However, the web panels used in prefabricated wood I-joists must often perform to higher levels. As a result, specific material properties are key to prefabricated wood I-joist performance. The following requirements provide a procedure for bench marking web stock material. This section specifies a minimum level of requirements for web material used in the manufacture of prefabricated wood I-joists. Table 1 specifies a set of tests, which shall be conducted on each supplier's web material. As an alternative the tests in Table 1 need not be conducted on plywood webs provided the shear test frequency specified in Section 6.4.1 is doubled for all prefabricated wood I-joists with plywood webs. Each supplier's production facility must be qualified under these guidelines. The web material supplier quality assurance program shall also be monitored by a qualified agency.

Current manufacturers of prefabricated wood I-joists with OSB webs are not required to redo the full scale tests listed in Section 11.2.2 for existing OSB web suppliers. Those manufacturer's, with the review and approval of the qualified agency, may use existing quality assurance data to meet the intent of this section.

11.1.1 Product Marking

Each web panel, as received from the web panel manufacturer shall as a minimum have sufficient face markings to establish: date and shift of manufacture and plant identification. Additional markings as described in the prefabricated wood I-joist manufacturer's manufacturing standard, for the purpose of confirming the grade of the board and the name of the web panel manufacturer's qualified agency may include: (1) panel markings conforming to either PS-1, PS-2 or CAN/CSA O325.0, or (2) proprietary marking signifying this information or (3) no additional face markings, but each shipment must be accompanied by a certificate confirming the material produced met the minimum quality control requirements of the web panel manufacturer's qualified agency for the specific dates and shifts included in the shipment.

11.1.2 Web Panel Dimensional Tolerances

Web panel dimensional tolerances, including length, width, thickness and squareness shall be established by the prefabricated wood I-joist manufacturer. Tolerances shall be appropriate for the specific manufacturing process utilized by the prefabricated wood I-joist manufacturer.

Note: *Standard sheathing panel tolerances are typically inappropriate for use with prefabricated wood I-joist web panels.*

11.2 Test Requirements for Web Material

Minimum requirements for prefabricated wood I-joist web material shall be as specified in Section 5.2 of ASTM D 5055. A test program shall include as a minimum, the following:

11.2.1 *Small Scale Web Panel Bench Mark Tests* - The required small scale web panel bench mark tests may be conducted at the web panel manufacturer's facility or the prefabricated wood I-joist manufacturer's facility or both.

11.2.1.1 A minimum of fifteen (15) full-size panels shall be selected randomly from the full production run of the bench mark web stock material, and tested as per Table 1.

11.2.1.2 Significant changes in wood species (or species proportions), adhesive or the web stock material manufacturing process requires establishment of a new benchmark.

11.2.2 *Full Scale Prefabricated Wood I-Joist Tests* - The required full scale prefabricated wood I-joist tests shall be witnessed by a qualified agency.

11.2.2.1 Each prefabricated wood I-joist manufacturing facility using the qualifying web stock material must be qualified in accordance with Sections 11.2.2.2 through 11.2.2.6, below.

11.2.2.2 *Shear* - Ten shear tests per depth shall be conducted at the extreme depths for each joist series group at each manufacturing facility.

11.2.2.3 *Analytical Moment* - All prefabricated wood I-joists which have moment capacities determined in accordance with Section 6.3.1 of ASTM D 5055, require tests in accordance with Section 6.3.2 of ASTM D 5055. Exception: only ten tests per depth are required for each web thickness at the minimum and maximum depths on all products using the same web properties (MOE and shear modulus). Where products with the same shear design values are produced at more than one manufacturing facility, and are recognized as the same by code evaluation reports, product from only one representative manufacturing facility need be tested.

11.2.2.4 *Moment, Empirical Alternative 1* - All prefabricated wood I-joists which have moment capacities determined in accordance with Section 6.3.3.4 of ASTM D 5055, require tests in accordance with Sections 6.3.3.1 and 6.3.3.2 of ASTM D 5055.

Exception: Only ten tests per depth are required for each web thickness at the minimum and maximum depths on all products using the same web properties (MOE and shear modulus). Where products with the same shear and moment design values are produced at more than one manufacturing facility, and are recognized as the same by code evaluation reports, product from only one representative manufacturing facility need be tested.

11.2.2.5 *Empirical Method Alternative 2* - All prefabricated wood I-joists which have moment capacities determined in accordance with Section 6.3.3.5 of ASTM D 5055, require tests in accordance with Sections 6.3.3.1 and 6.3.3.2 of ASTM D 5055.

Exception: Only ten tests per depth are required for each web thickness at the minimum and maximum depths on all products using the same web properties (MOE and shear modulus). A linear regression analysis of the mean values shall have a coefficient of determination (r^2) of at least 0.90. Prefabricated wood I-joists which do not meet this requirement require ten tests at the depth with which the back calculated net section flange tensile stress is highest, in addition to the tests required at the minimum and maximum product depths. A complete set of tests as described herein are required at each manufacturing facility.

11.2.2.6 *Stiffness and Creep* - The test specimens required by Sections 11.2.2.3, 11.2.2.4 and 11.2.2.5 shall be tested in accordance with Section 6.5 of ASTM D 5055.

11.3 Test Data Analysis

The test data shall be analyzed using simple statistics including mean, standard deviation and coefficient of variation and should be presented in a summary format. The prefabricated wood I-joist manufacturer shall use the small scale web panel bench mark test results as a bench mark against the test results for future incoming shipments to verify that the material continues to maintain the properties that bench marking was based on. The tests required in Section 11.2.2. must meet all applicable ASTM D 5055 requirements.

11.4 Quality Assurance Monitoring

11.4.1 *Required Tests and Minimum Frequency*: - Periodic quality assurance testing and monitoring shall be conducted on web stock material used in the manufacture of prefabricated wood I-joists. This guideline outlines recommended minimum tests and monitoring procedures and establishes minimum test frequency requirements for OSB and plywood.. The tests detailed in Table 1 shall be performed on each species, web panel type (OSB or plywood), grade and thickness for each web material manufacturing plant. The quality assurance tests required by Section 11.4 may be conducted at either the web panel manufacturers or the prefabricated wood I-joist manufacturer's facility. When these tests are performed at the web panel manufacturer's facility, the prefabricated wood I-joist manufacturer shall specify, to the web panel manufacturer, all of the required tests, test limits and frequencies. The prefabricated wood I-joist manufacturer shall obtain and maintain monthly records from the web panel manufacturer that demonstrates compliance with Section 11.4. The monthly summary report required in Section 5.3 shall include copies of all required tests from each web panel manufacturer and an analysis that demonstrates compliance with the requirements of this Section 11.4.

11.4.2 *Web Stock Lot* - For purposes of this guideline, a "web stock lot" is defined as the equivalent of up to 12 hours of continuous web panel production. This is approximately 500,000 square feet of web panel material.

11.4.3 *Web Material Testing and Monitoring* - One panel shall be randomly selected for testing as described in Section 11.4.2 from each web stock lot, for each web panel supplier, grade and thickness.

11.4.4 All tests listed in Table 1 shall be conducted on specimens cut from each panel selected per Section 11.4.3.

11.4.5 *Evaluation Criteria*

11.4.5.1 A monthly mean of test results on the properties listed in Table 1 shall be maintained by the prefabricated wood I-joist manufacturer for each web material grade and thickness. As a minimum, the test data shall be compared to the supplier's small-scale benchmark test results on a monthly basis. Declining trends in the monthly means may require further investigation. This investigation may include, among other things, a review of both the web material manufacturer's and the prefabricated wood I-joist manufacturer's quality assurance program daily procedures. It may also require more intensive testing or a testing program conducted jointly by the web material manufacturer and the prefabricated wood I-joist manufacturer.

11.4.5.2 Six-month test averages shall be compared to the data from the supplying plants original small-scale benchmark test program. When average differences in test results greater than 10% (except 5% on density as discussed below) occur, an investigation to determine if the property change is affecting the prefabricated wood I-joist performance is recommended. Since variations in density affects many properties, such as EI, edgewise shear and internal bond, the 5% variation is recommended as a limit for density before an investigation should be conducted. Variations in excess of this shall require investigation of web material performance and the affect it may have on prefabricated wood I-joist shear and other web related properties.

11.4.6 *Record Keeping* - The prefabricated wood I-joist manufacturer shall maintain a supplier test data file. All checks routinely made on incoming web stock material and the results of all tests required by Table 1 shall be recorded and summarized on a monthly basis.

Table 1.

Minimum Small Scale Web Panel Bench Mark and Quality Assurance Tests

Property	Minimum Number of Specimens (Bench Mark and Q.A. Tests)	Test Methods Noted in:	Comments
EI	Perp: 2 specimens per panel Para: 2 specimens per panel	ASTM D 1037[(1)]	
Flat Bending (moment) or Rail Shear (MC = "as manufactured")	Perp: 2 specimens per panel Para: 2 specimens per panel	ASTM D 1037[(1)] PS-2	Dry and single cycle conditioned tests specimens to be side matched
Flat Bending (moment) or Rail Shear[(3)(A)] (single cycle MC) (OSB only)	Para: 2 specimens per panel	ASTM D 1037[(1)] PS-2	Dry test and single cycle conditioned test specimens to be side matched. See Table notes for more details on moisture cycling.
Thickness Swell or (optional) Irrecoverable Thickness Swell[(B)] (OSB only)	2 specimens per panel	ASTM D 1037	See Table Notes for more details.
Internal Bond (OSB only)	5 specimens per panel	ASTM D 1037	
Panel Density[(2)]	2 specimens per panel	ASTM D 2395	
Linear Expansion (optional)	Perp: 2 specimens per panel Para: 2 specimens per panel	ASTM D 1037 or PS-2	

(1) Optional specimen sizes are permitted. Sizes of 12" x 24" and 4-1/2" x (24 x thickness) are common choices for flat bending tests. EI and flat bending dry are typically derived from the same specimens.
(2) Panel density can be obtained from other test specimens, independent test specimens tested for panel density or from two full panels.
(3) The soak-redry-test-dry or soak-test-wet strength retention developed during benchmark testing shall be used to establish the minimum quality assurance test requirements.

Table Notes: General Information

General: The reference standards listed in Table 1 are intended to be used to establish the procedures used for these web material tests. Test reports shall document those provisions of the referenced standards that are not used or are used with modifications. Each testing facility shall maintain records that indicate the precise details of the test procedures that they employ to comply with the Table 1 provisions.

Specific:

(A) Flat Bending (moment) or Rail Shear (single cycle MC):

In addition to the details provided in the Table 1, note that two different types of "single cycle" conditioning may be used for these tests:

(1) Soak-Test-Wet: Specimens are placed in a rack or similar device, to insure free movement of water and air around the specimens. The specimens are then placed in a vacuum-pressure vessel, which is filled with 65±10°F water. A vacuum of 27±2 inches of Hg is applied for 30 minutes. The specimens are then soaked for 30 minutes at atmospheric pressure, and then removed from the pressure vessel. An acceptance level of 50% strength retention is common.

(2) Soak-Redry-Test-Dry: Specimens are conditioned as in (1) above followed by oven drying. An acceptance level of 75% strength retention is common.

(B) Thickness Swell (TS) is based on comparison of a "baseline" measurement with a "wet" measurement. In typical industrial applications, the baseline measurement comes from panels without special moisture conditioning. A common basis for the wet measurement is the 24-hour soak. Proper test procedures will document preconditioning, if any, the measured or assumed specimen MC, will specify the precise nature of the measuring device and the location of the thickness measurements; e.g., 0.75 inch diameter anvil, centered 1 inch in from the edge of the specimen, average of four thickness measurements taken at the midpoint of each edge of the specimen. Optional specimen sizes and testing criteria are permitted. A specimen size of 6 inches x 6 inches is commonly used. Moisture content recording is not necessary for product tested at the OSB mill, where such is generally 3% or less. Differences between test procedures and their evaluation criteria for thickness swell after wetting versus irrecoverable thickness swell after wetting and redrying are discussed in the next section.

Irrecoverable thickness swell (ITS) is based on comparison of a "baseline" measurement with a moisture cycled "re-dry" measurement. Proper test procedures will document preconditioning, if any, the measured or assumed specimen MC, will specify the precise nature of the measuring device and the location of the thickness measurements; e.g., 0.75 inch diameter anvil, centered 1 inch in from the edge of the specimen, average of four thickness measurements taken at the midpoint of each edge of the specimen. Optional specimen sizes and testing criteria are permitted. A specimen size of 6 inches x 6 inches is commonly used.
A common moisture cycle procedure is as follows:
- Measure specimen thickness (specify conditioned or as manufactured)
- Submerge specimens in vacuum vessel filled with 150º F water.
- Draw 24 inches Hg for 30 minutes.
- Release vacuum and continue to soak for 30 minutes. Remove.
- Place specimens in 217º F oven and dry to zero moisture content.
- Measure specimens for thickness.

APPENDIX B

B1.0 INTRODUCTION

The purpose of this appendix is to integrate an ISO 9000-2000 series Quality Management System with quality control programs currently being utilized by engineered wood products evaluation report holders.

1.1 Scope: This appendix establishes four different Quality Assurance Levels for a manufacturer using a documented Quality Management System. Level I requirements noted in Table 3.1 are set to coincide with the historical engineered wood industry practices and ICC-ES AC14 requirements.

B2.0 DEFINITIONS

Standard definitions for a Quality Management System are given in ISO 9000-2000. Definitions of terms specific to this document are given below.

2.1 Manufacturer: For the purpose of this document, a firm or corporation producing a product that complies with AC14. A manufacturer is considered to be an organization as defined in ISO 9000-2000.

2.2 Accredited Inspection Agency: A third party inspection agency employing third party auditors complying with ISO/IEC Standard 17020 and accredited by IAS or by an accreditation body that is a partner of IAS in a Mutual Recognition Arrangement (MRA).

2.3 Quality Manual: For the purpose of this document, a quality manual is a written document meeting the requirements of AC10 and AC14. The initial Quality Manual and all revisions shall be signed and dated by the TPTE and MTE.

2.4 Manufacturer Technical Expert (MTE):
A quality professional employed by the manufacturer who provides specific knowledge of or expertise on products covered under AC14 and has demonstrated competence in managing and implementing a quality management system.

2.5 Third Party Technical Expert (TPTE):
A quality professional employed by the accredited inspection agency who provides specific knowledge of or expertise on products covered under AC14 and has demonstrated competence in managing a quality audit system.

2.6 Manufacturer Plant Technical Director (MPTD):
A quality professional employed by the manufacturer who has demonstrated competence in implementing a quality management system at the plant level.

2.7 Third Party Auditor (TPA):
A quality professional employed by the accredited inspection agency who has demonstrated competence in auditing a quality management system at the plant level.

2.8 Monthly Quality Report:
The monthly quality report shall contain a summary of product performance by grade or series with a comparison to requirements and a discussion of significant changes in raw materials or process.

B3.0 QUALITY MANAGEMENT SYSTEM REQUIREMENTS:

3.1 The manufacturer shall establish and implement a quality management system that is fully documented per the requirements of Table 3.1. The documented quality management system shall describe the manufacturer's procedures and quality activities for ensuring that the products meet the specified requirements.
3.2 The manufacturer, in concert with an accredited inspection agency, shall prepare and submit to ICC-ES its documented quality manual, including a cross-reference matrix to the quality management system, ensuring that the data in Section 2 of AC10 and the written procedures noted in Section 4 of this acceptance criteria have been included.
3.3 The MPTD shall submit a monthly quality report to the TPTE and MTE.
3.4 The submitted quality management system shall be assigned a Level I, II, III or IV per the following requirements:

Table 3.1 Quality Assurance Levels I, II, III or IV Manufacturers

	Level I Manufacturer	Level II Manufacturer	Level III Manufacturer	Level IV Manufacturer
Quality Concept	Product Audit through Industry Standards	Product Audit through Industry Standards	ISO Compliant – Ready to Register (7)	ISO Registered (3)
Minimum Audit Frequency by TPA	12 / year	6 / year	4 / year	3,2 / year (4)
MTE and MPTD Education and Experience	Industry Experience	Per Section 4.0	Per Section 4.0	Per Section 4.0
Intra-Company Quality Audits at Every Plant by MTE (1),(2),(8)	N/A	N/A	1 / year	1 /year
Plant Quality Audit by MPTD (6), (8)	N/A	1 / year	1 / year	2 / year
Review of QA Test Results (9)	1 / year (MTE) Monthly (MPTD)	1 / year (MTE) Monthly (MPTD)	2 / year (MTE) Monthly (MPTD)	2 / year (MTE) Monthly (MPTD)
Quality Manual	Yes	Yes	Yes	Yes
Documentation per ISO 9001-2000	No	No	Yes	Yes
Quality Plan (5)	No	Yes	Included in ISO Documentation	Included in ISO Documentation
Monthly QC report by MPTD required	Yes	Yes	Yes	Yes

1 - Intra-company auditors can be from different plants. For companies with multiple plants, the MTE may designate a lead auditor that satisfies the education and experience requirements of an MTE. The MTE however, still retains the primary responsibility for the Quality Management System.
2 - External auditors may be contracted in cases where a company has only one plant.
3 To move from Level III to Level IV requires successful documentation under AC14 for a minimum of two years and ISO 9001-2000 certification. Additionally, requires an on site joint audit with third party auditor and ICC ES representative participation. Registration shall be conducted by an ISO-9001 Agency Registered by a Registrar accredited by an International Accreditation Forum (IAF) member accreditor or an ISO-9000 Registrar accredited by an IAF member accreditor.
4- Requires successful documentation and ISO registration for a minimum of two year for a move from three audits to two audits per year by the accredited inspection agency. Additionally, requires an on-site joint audit with third party auditor and participation of ICC ES representative.
5– A Quality Plan provides information beyond the Quality Manual and shall be verified per Section 3.5. It shall include revision-controlled documents, retrievable records and procedures defining the following:

-Product Identification and Traceability from raw materials to finished goods.
-Corrective and Preventative Action Process that can track / trend incidents of nonconforming product from identification through root cause analysis to resolution and closure.
-Internal auditing process to ensure that the procedures are being followed.

6 – The MPTD shall audit each element of the Quality Plan (Level II) or Quality Management System (Levels III and IV).
7 – Requires review of documentation by the Accredited Inspection Agency and the Manufacturer statement of self-certification.
8 - The Intra-Company Quality Audit by MTE and Plant Quality Audit by the MPTD are conducted separately.
9 – The MTE shall review QA test results per D5055, Section 11. See Sections 2.8 and 3.3 for MPTD requirements.

3.5 For Levels II, III and IV, the TPA shall verify conformity to the Quality Plan at each audit. For Levels III and IV, a senior-level TPA appointed by the TPTE shall audit the plant together with the TPA once each year.

3.6 Follow-up inspections: The manufacturer shall obtain the services of an IAS-accredited inspection agency, which is accredited for the specified discipline, to conduct inspections of the fabrication facility per the minimum inspection frequency specified in Table 3.1.

Table 3.2 Educational and Experience Requirements for Accredited Inspection Agency Personnel

Quality Level (1)	Level I	Level II	Level III	Level IV
Third Party Accreditation	IAS Accredited Inspection Agency	IAS Accredited Inspection Agency	IAS Accredited Inspection Agency	IAS Accredited Inspection Agency (2)
TPTE Education and Experience	Industry Experience	Per Section 4.0	Per Section 4.0	Per Section 4.0
TPA Education and Experience	Industry Experience	Per Section 4.0	Per Section 4.0	Per Section 4.0
Third party witness of Manufacturer manufacture / testing with TPA	Industry Experience, Able to Verify Compliance to Appropriate ASTM Standards	Same as Level I	Same as Level I	Same as Level I

1 – Table 3.1 for quality system elements.
2 - The third party shall be IAS Accredited. The organization that ISO registers the manufacturer (i.e. separate organization or IAS Accredited Agency) shall be either: a) ISO-9001 Registered by a Registrar accredited by an International Accreditation Forum (IAF) member accreditor or b) ISO-9000 Registrar accredited by an IAF member accreditor.

3.7 Audit by ICC ES Representative: Prior to advancement to Level IV, the manufacturer is required to undergo an onsite assessment by an ICC ES Representative. This audit will be conducted jointly with the accredited inspection agency. The purpose of this joint audit is to determine the manufacturer's compliance with the documented quality management system, and to assess the inspection procedures of the inspection agency. After the audit frequency has been established by ICC ES representative any reductions in audit frequency by the third party (i.e. promotion from 3 to 2 audits / year) shall require an additional joint audit and appropriate documentation that the third party inspection agency has reviewed and approved the revised quality management system. Documentation shall be retained on file by the third party agency and be available to ICC ES upon request. ICC ES shall approve any ISO / Accredited Agency combination inspections.
3.7.1 Prior to advancement to Levels II or III, the manufacturer is required to undergo an assessment by the TPTE. The purpose of the assessment is to determine if the manufacturer's quality system meets the minimum requirements of the proposed Quality Assurance Level in Table 3.1. Documentation of the assessment shall be retained on file by the third party agency and be available to ICC ES upon request.

3.8 Manufacturer Technical Expert (MTE) Responsibilities: The manufacturer shall appoint an MTE that reports directly to the highest level of authority within the business or operating unit of the organization. The MTE shall be capable of providing leadership within the quality organization in the following areas:
3.8.1 Development of organizational structure
3.8.2 Formulation of quality policies and procedures
3.8.3 Establishment of quality performance goals
3.8.4 Implementation of quality control tools and process control limits
3.8.5 Statistical analysis and qualitative assessment of process and product performance
3.8.6 Supplier assessment, certification, feedback and improvement
3.8.7 Follow-up on customer feedback or field complaints
3.8.8 Establish training and development programs for MPTD and other associates
3.8.9 Maintain the manufacturer's documented quality system.
3.8.10 Monitor the effective implementation of the manufacturer's documented quality system.
3.8.11 Assure that periodic internal audits are conducted and documented, and that corrective actions are implemented.
3.8.12 Assure that annual management reviews are conducted and documented to assure the adequacy and effectiveness of the quality system. Management reviews shall include a summary and a documented plan of action for improvement.
3.8.13 Be familiar and demonstrate knowledge of codes and standards as applicable to the quality assurance program.
3.8.14 Be an employee of the manufacturer who reports quality information and decisions directly to the highest level of authority within the business or operating unit of the organization.

3.9 Manufacturer Plant Technical Director (MPTD) Responsibilities: The manufacturer shall appoint an MPTD at each production facility who shall:
3.9.1 Understand the organizational structure
3.9.2 Implement the quality policies and procedures at the plant level
3.9.3 Monitor and report the plant quality performance to the MTE
3.9.4 Apply quality control tools and process control limits at the plant level

3.9.5 Collect and report information to provide a qualitative assessment of process and product performance
3.9.6 Collection information for supplier assessment, certification, feedback and improvement
3.9.7 Investigate customer feedback or field complaints
3.9.8 Participate in training and development programs
3.9.9 Maintain the manufacturer's documented quality system at the plant level
3.9.10 Be responsible for overall workmanship and for compliance to the documented procedures established by the manufacturer. Although inspections may be delegated to qualified personnel during the receipt and in-process stages of assembly, it is the responsibility of the MPTD to ensure that inspections are performed.
3.9.11 Be responsible for ensuring that incoming raw materials are properly identified and inspected for compliance with quality plans and specifications.
3.9.12 Be responsible for ensuring that the final QC test results can be traced back to the incoming raw materials, the quality assurance records and the responsible plant personnel.
3.9.13 Train and monitor performance of other personnel collecting process or product performance data.
3.9.14 Be an employee of the manufacturer that reports quality information directly to the MTE.

B4.0 EDUCATION AND EXPERIENCE

4.1 Education and Experience of MTE, MPTD, TPTE or TPA

MTE and MPTD shall be identified in the Quality Manual on the basis of appropriate education, training and experience such that the individuals are competent to take full charge of their responsibilities in accordance with the requirements noted here and also as required by the accredited inspection agency.

4.1.1 The TPTE shall verify the education and experience, proof of professional ism and core knowledge of the MTE.
4.1.2 The MTE shall verify the education and experience, proof of professional ism and core knowledge of the MPTD.

4.2 Experience Waiver for Education

If an individual has completed a degree from an accredited college, university or technical school or certification by the American Society for Quality, part of the experience requirement will be waived as follows:

4.2.1 Diploma from technical or trade school or advanced degree from non-related field – one year waived
4.2.2 Associate degree in Forest & Wood Sciences, Engineering or a related field– two years waived
4.2.3 American Society for Quality (ASQ) certified Quality Improvement Associate, Quality Engineer, Reliability Engineer, Six Sigma Black Belt, or Quality Technician – two years waived
4.2.4 American Society for Quality (ASQ) certified Quality Auditor – three years waived
4.2.5 Bachelors degree in Forest & Wood Sciences, Engineering or a related field – four years waived
4.2.6 Master's or Doctorate degree in Forest & Wood Sciences, Engineering or a related field – five years waived
4.2.7 American Society for Quality (ASQ) certified Quality Manager – five years waived
4.2.8 Professional Engineer registration – ten years waived

4.3 Proof of Professionalism

The MTE, MPTD, TPTE and TPA shall demonstrate proof of professionalism in one of three ways:
4.3.1 Membership in ASQ, ASCE or one other trade association applicable to the product produced
4.3.2 Registration as a Professional Engineer
4.3.3 The signatures of two persons – either an accredited inspection agency, ASQ or trade association member which can verify that the individual is a qualified practitioner of the quality sciences.

4.4 Manufacturer Technical Expert (MTE)

The MTE shall meet the following minimum requirements:

4.4.1 Ten years of on-the-job experience in one or more areas of Sections 3.8 or 3.9 (see Education Experience Waiver, Section 4.2). A minimum of five years of this experience shall be in a decision-making position. "Decision-making" is defined as the authority to define, execute or control projects/ processes and to be responsible for the outcome. This may or may not include management or supervisory positions. Current or previous certification by the American Society for Quality (ASQ) as a Quality Auditor, Reliability Engineer, Software Quality Engineer, or Quality Engineer applies to job experience. On-the-job experience may be earned in accordance with the education requirements in Section 4.2.

4.4.2 The MTE shall demonstrate an adequate knowledge of core subjects by satisfying education requirements of Sections 4.2.5, 4.2.6 or a minimum of 25 Continuing Education Unit (CEU) or Recertification Unit (RU) credits (or equivalent hours of college education) from the list of topics in Sections 4.4.4 or 5.0. At least 15 CEU or RU credits shall come from the core knowledge topics in Section 5.3.3. A one-year grace period, beginning on the date of the job appointment, is permitted to acquire the appropriate number of credits while working in the MTE position.

4.4.3 The MTE shall demonstrate ongoing training by completing at least 4.5 RU credit every three years in accordance with Section 4.4.4.

Note: 4.5 credits, or 45 hours, is equivalent to 15 hours per year, which was considered as a typical benchmark for a Professional Engineer.

4.4.4 One RU credit is equivalent to one CEU credit or ten hours of participation. Recertification units can be earned in the following areas:
4.4.4.1 Author or co-author of a published book or journal article
4.4.4.2 Reviewer of a published article or book
4.4.4.3 Participation in Standards Committees such as ASTM, ANSI, etc.
4.4.4.4 Participation in Trade Association Technical Committees or Conference Presentations
4.4.4.5 Participation in ICC ES or ICC ES approved technical meetings
4.4.4.6 Being an instructor or student within the topics of Section 5

4.5 Third Party Technical Expert (TPTE)
The TPTE shall meet the following minimum requirements:

4.5.1 Ten years of on-the-job experience in one or more areas related to Quality Assurance in the wood products industry (see Education Experience Waiver, Section 4.2). A minimum of five years of this experience shall be in a decision-making position. “Decision-making” is defined as the authority to define, execute or control projects/ processes and to be responsible for the outcome. This may or may not include management or supervisory positions. Current or previous certification by the American Society for Quality (ASQ) as a Quality Auditor, Reliability Engineer, Software Quality Engineer, or Quality Engineer applies to job experience. On-the-job experience may be earned in accordance with the education requirements in Section 4.2.

4.5.2 The TPTE shall demonstrate an adequate knowledge of core subjects by satisfying education requirements of Sections 4.2.5, 4.2.6 or a minimum of 25 CEU or RU credits (or equivalent hours of college education) from the list of topics in Sections 4.4.4 or 5.0. At least 15 CEU or RU credits shall come from the core knowledge topics in Section 5.3.3. A one-year grace period, beginning on the date of the job appointment, is permitted to acquire the appropriate number of credits while working in the TPTE position.

4.5.3 The TPTE shall demonstrate ongoing training by completing at least 4.5 recertification units (RU) every three years in accordance with Section 4.4.4.

Note: 4.5 credits, or 45 hours, is equivalent to 15 hours per year, which was considered as a typical benchmark for a Professional Engineer.

4.6 Manufacturer Plant Technical Director (MPTD)
The MPTD shall meet the following minimum requirements:

4.6.1 Two years of on-the-job experience in one or more areas in Sections 3.9 (see Education Experience Waiver, Section 4.2). On-the-job experience may be earned in accordance with the education requirements in Section 4.2.

4.6.2 The MPTD shall demonstrate an adequate knowledge of core subjects by satisfying education requirements of Sections 4.2.2, 4.2.5, 4.2.6 or a minimum of 10 CEU or RU credits (or equivalent hours of college education) from the list of topics in Sections 4.4.4 or 5.0. At least 5 CEU or RU credits shall come from the core knowledge topics in Section 5.3.3. One year of experience beyond the minimum of three years may be substituted for one CEU or RU. A maximum of 5 credits may be obtained through additional experience served under the guidance of a MTE. A one-year grace period, beginning on the date of the job appointment, is permitted to acquire the appropriate number of credits while working in the MPTD position.

4.7 Third Party Auditor (TPA)
The TPA shall meet the following minimum requirements:

4.7.1 Three years of on-the-job experience in one or more areas related to Quality Assurance in the wood products industry (see Education Experience Waiver, Section 4.2). On-the-job experience may be earned in accordance with the education requirements in Section 4.2.

4.7.2 The TPA shall demonstrate an adequate knowledge of core subjects by satisfying education requirements of Sections 4.2.2, 4.2.5, 4.2.6 or a minimum of 12 CEU or RU credits (or equivalent hours of college education) from the list of topics in Sections 4.4.4 or 5.0. At least 6 CEU or RU credits shall come from the core knowledge topics in Section 5.3.3. One year of experience beyond the minimum of three years may be substituted for one CEU or RU. A maximum of 6 credits may be obtained through additional experience served under the supervision of a TPTE. A one-year grace period, beginning on the date of the job appointment, is permitted to acquire the appropriate number of credits while working in the TPA position.

B5.0 Continuing Education Credits

5.1 The definition of one CEU credit is ten contact hours of participation in an organized continuing education / training experience under responsible, qualified direction and instruction. A contact hour is defined as a 60 minute clock hour of interaction between student and instructor.

5.2 If CEU credits are not offered for a given course, then recertification (RU) credits can be calculated. The instructor shall record the hours of interaction between the student and instructor and assign one RU credit for every ten hours of participation in training.

5.3 Topics

5.3.1 All ASQ certified courses are deemed acceptable for CEU credits.

5.3.2 Courses, conferences and seminars offered within the industry are deemed acceptable, provided CEU credits are offered.

5.3.3 The following list of topics is considered to be the core knowledge of the overall training program:

ICC Codes, Approvals, Evaluation and Building Official Acceptance
Role of the Third Party Agency and Internal Auditing
North American Wood Design (NDS, AITC, etc)
Structural versus Serviceability Requirements
ASTM or ANSI Product Standards
Grading Procedures for Base Materials
ASTM or ANSI Testing Procedures, Failure Modes
Third Party Witnessing and Report Requirements
Statistical Method Used to Assign Design Properties
Fastener Testing / Design
Preservative Treatment Effects on Product (if applicable)
Durability and Adhesive Test Requirements
Product Labeling and Traceability to Process
Business Corporate Quality Structure, Policies and Procedures
Business Quality Goals
Continuous Improvement and Innovation
Assessing Capability of Production Personnel
Procedures for Nonconforming Product or Base Materials
Application of ISO 9000 Standards to Quality Process
Auditing Procedures
Internal Auditing Procedures
ISO 17020 requirements
ISO/IEC 17025 requirements
Document Control and Record Keeping within the Organization
Fire Testing / Performance
(Other topics as approved by Accredited Inspection Agency or ICC ES)