WOOD I-JOIST MANUFACTURERS ASSOCIATION

QUALITY ASSURANCE GUIDELINES

FOR

PREFABRICATED WOOD I-JOISTS

April 1999

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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 7.4.4 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.