



STUDY GUIDE

WACEL

STRUCTURAL STEEL SPECIAL INSPECTOR LEVELS I and II

May 2023

Structural Steel Inspector, Levels I and II

Study Guide

Purpose: The purpose of this study guide is twofold:

- a. To be an informational document to owners, engineers, and code officials describing the depth and breadth of knowledge expected of technicians in order to obtain WACEL Structural Steel certification(s).
- b. To be a resource document for technicians seeking these certifications to understand the scope of the evaluation, applicable references, and a clear delineation of the learning objectives that they are expected to master.

General:

The WACEL Structural Steel Certification Program comprise of two certifications. Level I certification is awarded to individuals who successfully complete WACEL Structural Steel certification requirements that includes demonstrating knowledge of a full range of applicable structural steel construction topics with the exception of advanced welding topics that require more significant skills, training, and experience.

Level II certification is awarded to those who are certified as a Level I technician who also obtains a Certified Welding Inspector (CWI) from the American Welding Society or equivalent certification. A skills matrix showing the two levels of certification is attached.

Certification exam questions use are based on the procedural and inspection requirement for the technical areas contained in the scope of the Learning Objectives contained in this Study Guide. Users should understand that the “*International Building Code*” now refers to Chapter N of AISC 360 for Quality Assurance Inspections rather than the more-transitional Special Inspections for Structural Steel. How this is implemented should be based on a project-by-project basis based on drawings and specifications, AHJ policy, and local conditions.

Evaluation:

The in-person examination is a 4-hour, open-book examination. The online version is 4.5 hours. Both versions consist of 100 multiple-choice questions. 75 questions require an understanding of and familiarity with the various required references listed in this Study Guide. The other 25 questions are based on project drawings and specifications that are provided to the candidates at the time of the examination.

The questions are organized into sections by topic. A minimum overall grade of 75 percent is required for certification. In addition, a minimum of 70 percent is required on the project drawings and specification questions.

The drawings and the selected ICC ESR for post-installed anchors (addressed later) that will be provided for the plan-reading portion of the examination are a partial set of drawings from an actual project. Select sheets have been extracted from:

- a. The structural drawings.
- b. The steel erection drawings.
- c. Stud layout drawings.
- d. Deck layout drawings.
- e. Joist installation drawings.
- f. ESR-3187.

WACEL does **NOT** provide the below listed references. Examinees can only bring these publications with them to use during the test. References must be “clean” copies. No markings or notes in these documents are permitted. No other materials beyond a non-programmable calculator, a pencil, and the approved reference publications can be brought into the test area. Exam questions are based on the listed editions.

Paper will be provided for completing calculations, but it must be turned into the proctor at the completion of the examination.

Safety:

This certification program – to include the examination – does not address the safety issues or the health hazards associated with structural steel erection, testing, or observations. It is the responsibility of each candidate and their employer to be knowledgeable and to comply with all health and safety requirements specified by code officials, governmental agencies, and each employer’s health and safety program.

Required References MUST be Brought to the Exam by Examinee:

- A. “International Building Code,” (Chapter 17, Special Inspections, and, Chapter 2, Definitions only), International Code Council, 2018.
- B. “Steel Construction Manual,” American Institute of Steel Construction, Inc., ^{15th} Edition, 2017.
- C. “Specification for Structural Steel Buildings” (2016), American Institute of Steel Construction, Inc., included in Reference B. This publication is also identified as AISC 360-16.

- D. "Specification for Structural Joints Using High-Strength Bolts" (2014), Research Council on Structural Connections, included in Reference B.
- E. "Code of Standard Practice for Steel Buildings and Bridges" (2016), American Institute of Steel Construction, Inc., included in reference B. This publication is also identified as AISC 303-16.
- F. "Structural Welding Code–Steel," American Welding Society (AWS) D1.1, 2020.
- G. "Structural Welding Code-Sheet Steel," American Welding Society (AWS) D1.3, 2018.
- H. "Handling and Erection of Steel Joists and Girders," Technical Digest 9, Steel Joist Institute, 2008.
- I. "SDI Manual of Construction with Steel Deck," Steel Deck Institute (SDI) Publication MOC3, 2016.
- J. Guidelines for Inspection Cold-Formed Steel Structural Framing in Low-Rise Buildings," Technical Note G500-11), Cold-Formed Steel Engineers Institute (CFSEI), 2011.
- K. "Special Inspection Guidelines for Post-Installed Anchors," Concrete Anchor Manufacturer's Association (CAMA), 2011.
- L. ICC Evaluation Service Evaluation Report ESR-3187, "HILTI HIT-HY 200 Adhesive Anchors and Post Installed Reinforcing Bar Connections in Concrete," reissued March 2022.

NOTE: Where appropriate, detailed learning objectives contained in this Study Guide will make reference to more-specific sections of some of the above references to assist exam candidates in prioritizing their preparation and study efforts.

References that may be useful BUT are not required for the Exam:

- A. "Model Program for Special Inspection," International Code Council, 2012.
- B. "Structural Bolting Handbook," Steel Structures Technology Center, Inc., 2016 Edition.
- C. "Structural Welding Quality Handbook," Steel Structures Technology Center, Inc. 2016.
- D. "Code of Standard Practice for Cold-Formed Steel Structural Framing," American Iron and Steel Institute (AISI), 2020.

Scope:

In addition to a thorough knowledge of the references listed above, the specific areas the Level I exam focuses on include:

- An ability to review approved project documents and field erection drawings.
- Structural shapes, properties, and tolerances.
- Anchor rods and column bases.
- Structural steel erection and erection tolerances.
- Bolted connections:
 - RCSC specifications
 - Proper materials assembly
 - Equipment
 - General requirements
 - Snug-tight connection
 - Pre-tensioned bolts
 - Slip-critical connections
 - Arbitration
- Post-installed anchors.
- Simple fillet welds (single pass & NTE 5/16”) and welder qualifications/certifications.
- Structural shear studs, composite decks, and steel decks.
- Steel joists.
- Cold-formed steel structural framing.
- Proper reporting methods to include specific details of items inspected and documentation/identification of non-conforming items.
- General and structural steel topics of the IBC’s Special Inspection Program.
- Quality Control and Quality Assurance requirements addressed in Chapter N of AISC 360.

Limitations:

This certification does not replace the need for additional technician certifications that may be required by project specifications, code requirements, or good industry practice. These include, but are not limited to, certification as a “Certified Welding Inspector” as outlined by the American Welding Society and “Nondestructive Testing Level II” as defined by the American Society for Non-Destructive Testing in publication SNT-TC-1A.

The Level I certification does not require an inspector to be certified as a Certified Welding Inspector (CWI) or an equivalent certification. It does, however, require a basic understanding of welding sufficient to properly confirm the acceptability of basic fillet and puddle welds. This knowledge should allow the inspector to review simple, welded joist/girder bearing seat and bridging welds, shear studs, and welded metal deck

connections. The Level I inspector is expected to recognize those situations when the need for a more advanced welding inspector is required.

Application:

The exam candidate must submit a completed WACEL Exam Application prior to taking the exam (available on www.wacel.org). The individuals who are cleared to take this examination are expected to be experienced construction inspectors and/or should have relevant education/training background.

The application requires a Professional Engineer to endorse that the candidate has the skills, knowledge, and abilities to provide structural steel observation and testing services and to formally confirm and document the individual is eligible to take this examination and attest that the candidate has access to required references.

Examination candidates can bring a simple, 4-function calculator (no memory). Telephones are not authorized to be in the possession of the examinee. For in-person testing, candidates will be asked to show a photo identification. For online tests, candidates are required to provide an image of a photo identification with their application.

Learning Objectives:

The learning objectives listed below expand on the topics listed in the “Scope” section. They are intended to provide candidates with an outline of what is expected of them.

- A. Review approved structural drawings, specifications, shop fabrication drawings, and field erection drawings:
 - 1. Can verify that approved contract documents are being used, and knows the procedures if conflicts are noted.
 - 2. Understands the different methods that may be used to develop connection details for structural members.
 - 3. Can identify processes and procedures that may require continuous inspections.
 - 4. Can review approved contract documents and determine contract requirements to include proper size and grade of materials; connection details; fabrication and erection tolerances; necessary testing; and certifications needed for all materials, organizations, and individuals involved in the process.

5. Knows how to review responses to Requests for Information (RFIs) and approved submittals that may have been generated.
 6. Is also familiar with the drawing requirements of the "Specification for Structural Steel Buildings" and the AISC "Code of Standard Practice."
- B. Structural Shapes, Properties, and Tolerances based on the AISC's "Steel Construction Manual" and "Code of Standard Practice for Steel Buildings and Bridges":
1. Can identify section sizes and dimensions as outlined in Required Reference B.
 2. Is familiar with the ASTM A6 mill tolerances for camber, sweep, and other physical properties (extract in the AISC's SCM).
 3. Is able to identify on the Mill Test Reports the correct grade and verify compliance.
 4. Can confirm that proper piece marks have been applied in accordance with approved shop and erection drawings to include length tolerances.
 5. Is able to confirm that the proper sections are being used in accordance with approved contract documents.
 6. Knows procedures for checking both camber and sweep.
 7. Is familiar with the requirements and restrictions for shop painting.
- C. Anchor Rods and Column Bases:
1. Is familiar with the anchor rod requirements of Part 14 of the SCM, Section J9 of the "Specifications for Structural Steel Buildings," and Section 7 of the "Code of Standard Practice for Steel Buildings and Bridges."
 2. Can confirm proper grade, size, configuration, elevation, and relative alignment of anchor rods.
 3. Can verify approved leveling method.
 4. Knows allowable anchor rod hole sizes in column base plates.
 5. Is familiar with anchor rod washer requirements, nut tightening, and thread engagement.
 6. Knows the recommended criteria for grouting under column base plates.

- D. Structural Steel Erection and Erection Tolerances:
1. Can confirm the acceptability of column plumbness as specified by the AISC or project specifications.
 2. Is familiar with the erection guidance and tolerances established by the AISC.
- E. Bolted Connections:
1. Is familiar with the applicable sections of the RCSC specifications. This includes Sections 1-4 and 6-10 inclusive.
 2. Can determine applicable inspection information from Sections J3.1 to J3.5 of "Specifications for Structural Steel Buildings.
 3. Knows the types of bolts to be used and the joint types that must be specified in contract documents.
 4. Can confirm that the bolt assembly components are properly shipped, marked, and stored.
 - (a.) Size
 - (b.) Markings
 - (c.) Condition/cleanliness
 - (d.) Finish
 - (e.) Submittals
 - (f.) Storage
 5. Verifies that the calibration of the bolt tension calibration device is current, and when a tension calibrator is required.
 6. General requirements:
 - (a.) Can confirm correct size, type, and condition of bolt holes.
 - (b.) Can confirm that bolt assembly components are properly installed with regard to size, location, condition, orientation, and thread engagement.
 - (c.) Can confirm that the faying surfaces of plies in the bolted connection are in firm contact.
 - (d.) Can confirm the testing and inspection frequency required by the RCSC and project specifications.

- (e.) Knows what high-strength bolts can be reused and under what conditions.
- (f.) Knows the range of conditions that require the use of washers.
- (g.) Can determine from project documents when threads are allowed in a shear plane (“N”) and when they are excluded (“X”).

7. Snug-Tight (ST) Joints:

- (a.) Can verify that the bolts are in ST condition.
- (b.) Knows the inspection criteria for snug-tight connections.

8. Pre-Tensioned (PT) Joints:

- (a.) Knows the minimum pretensioning for pretensioned joints.
- (b.) Can determine the specified or approved pre-tensioning method.
- (c.) Can confirm that pre-installation verification of the bolt assemblies is being properly conducted.
- (d.) Knows how to properly document the pre-installation verification process.
- (e.) Knows the conditions that will require the pre-installation process to be redone to include a daily verification if torque wrenches are being used.
- (f.) Knows processes and the amount of time the inspector must be on site to confirm pre-tensioning depending on the method being used:
 - Turn-of-Nut.
 - DTIs.
 - “Twist-off” tension control (TC) bolts.
 - Torque wrench.
- (g.) Knows the correct orientation of DTIs and ASTM F436 washers based on location and which element is being turned.

9. Slip-Critical (SC) Joints:

- (a.) Knows the required condition of the faying surfaces prior to assembly.
- (b.) Knows the inspection criteria for slip critical connections.
- (c.) Knows the paint requirements for slip critical connections.

10. Is familiar with Arbitration:

F. Post-Installed Anchors:

- 1. Can confirm that the type of post-installed anchor being used is approved by the structural engineer of record.
- 2. Ensures that manufacturer's printed installation instructions (MPII) are available and are being used.
- 3. Can confirm that drilled holes are correct with respect to drill bit type, diameter, depth, and cleanliness.
- 4. Knows how the 2018 IBC defines and establishes the requirements of continuous or periodic inspections for post-installed anchors.
- 5. Can extract pertinent inspection and observation standards from an ICC-ES Report. ESR-3187 will be used as a sample. Questions based on the ESR will be considered as plan reading questions.

G. Basic Welded Connections and Welder Qualifications/Certifications:

- 1. Knows the general welding terms and definitions described in the AWS D1.1 and the AISC manual.
- 2. Knows the general requirements for welding inspections and inspector qualifications and duties as prescribed by the AWS D1.1.
- 3. Can perform visual inspections of single pass fillet welds, not to exceed 5/16", is familiar with quality requirements and measurement per AWS D1.1 including acceptable and unacceptable weld profiles, is familiar with visual inspection acceptance criteria per table 6.1, is familiar with other general requirements of AWS D1.1 as they relate to fillet welding and inspections and is familiar with allowable tolerances.

4. Is familiar with inspection requirements for welding corresponding to continuous or periodic inspections. Welding inspection requirements for WPSs, welder certifications, fitup, preheat, interpass temperatures, etc.
5. Filler Metals, Welding equipment and Processes. Is familiar with AWS requirements for inspection of WPS variables and execution.
6. Is familiar with fillet welding, Partial Joint Penetration and Complete Joint Penetration welding symbols and details.
7. Understands the concept of pre-qualified welded joints.

H. Shear/Nelson Studs:

1. Is familiar with the inspection, observation, and acceptance criteria for steel headed stud anchors contained in AWS D1.1.
2. Can evaluate the condition of the base metal prior to the welding of studs.
3. Can determine from the project drawings the quantity, size, and location of all required studs.
4. Knows the placement tolerances both longitudinally and from edges.
5. Can confirm that the proper type and size (diameter and length) of the studs being used.
6. Knows how to conduct and evaluate pre-production testing at the beginning of each day's/shift's work.
7. Can visually determine the acceptability of each stud during production testing.
8. Can conduct additional bend tests as required and/or specified.

I. Steel and Composite Decks:

1. Can extract pertinent structural information from approved deck layout drawings.
2. Can confirm that the on-site decking complies with the layout drawings as to thickness, depth, type, and finish.
3. Can determine the method of fastening of the deck to the structural members specified or addressed in the layout drawings (e.g., TEK screws, power or powder-driven pins, puddle welding, etc.).

4. If welding required, knows how to confirm welder qualifications with respect of type, position, and thickness and is familiar with the acceptance criteria as stated in AWS D1.3.
5. Can confirm the proper size and location of welds, and that welds meet visual acceptance criteria.
6. Verifies that decking is properly installed, supported, and positioned as specified in the deck layout drawings to include minimum end bearing distances.
7. Knows conditions when weld washers should be used.
8. Can verify that side lap connections are installed as required.

J. Steel Joists, Joist Girders:

1. Is able to visually inspect joists and girders for proper storage and any signs of distress, damage, or deformations.
2. Can confirm that joists and girders are properly placed as specified in the Joist Placement Plan (verifies tags with erection marks).
3. Is able to determine if minimum bearing distances are achieved.
4. Can confirm that all required bridging is properly installed.
5. Can confirm that joists and girders are laterally and vertically straight.
6. Verifies that complete and correct connections (bolted or welded) are accomplished in connecting joists or girders to bearing surfaces.
7. If required, verifies that vertical stabilizer plates are properly installed.

K. Cold-Formed Steel Structural Framing:

1. Is familiar with the CFSEI Tech Note G500-11, "Guidelines for Inspecting Cold-Formed Steel Structural Framing In Low Rise Buildings," Cold-Formed Steel Engineers Institute, 2011.
2. Knows that construction should conform to approved design documents.
3. Confirms that structural members being installed conform with specified size, type, spacing, and metallic coating.

4. Determines connecting screws, pins, or fasteners are in accordance with approved design documents and are used correctly for approved style, finish, and size; and that they comply with specified center-to-center spacing and edge distance requirements.
 5. Monitors that welding is in accordance with AWS D1.1 or D1.3, as applicable, and that welded areas are treated to retain corrosion resistance.
 6. Knows that bottom tracks need to be in full contact with foundation elements. Gaps up to ¼ inch are acceptable if gaps are filled using grout or load-bearing shims.
 7. Confirms that floor, roof, and ceiling framing is installed in accordance with approved construction documents.
 8. Is aware that studs for wall framing should be cut square such that the gap between the end of the stud and the track web is no greater than 1/8 inch.
 9. Knows that “sheathed” and “x-braced” shear walls must be installed as specified by the project’s design professionals.
- L. Reporting and Documentation of Non-conforming Items as described in AISC’s “Code of Standard Practice”:
1. Can document inspected work location and acceptability.
 2. Can classify inspected work as being compliant, incomplete, or non-conforming.
 3. Knows to whom and when reports of non-compliant work must be made.
- M. IBC’s Special Inspection Program:
1. Is familiar with the general requirements of the Special Inspections Program in Chapter 17 of the IBC to include inspector approval, notification of non-conforming work, and reporting.
 2. Is knowledgeable of the Special Inspection requirements for structural steel.
 3. Is aware that the Special Inspection section of the *International Building Code* now refers the user to Quality Assurance section of Chapter N of AISC 360 for Structural Steel.

4. Is aware of the differences between “periodic” and “continuous” inspections as well as how they compare to “perform” and “observe” inspection tasks introduced by AISC 360.
5. Is knowledgeable of the requirements for inspections of structural steel fabricators.

N. AISC 360, Chapter N:

1. Is familiar with the minimum requirements for quality control and quality assurance for structural steel systems and steel elements of composite members for buildings and other structures.
2. Is familiar with steel erector’s quality control procedures and minimum inspection requirements.
3. Is familiar with the minimum welding inspection tasks as listed in Tables N5.4-1 through N5.4-3 and bolting inspection tasks in Table N5.6-1 through N5.6-3.
4. Is aware of the differences between “periodic” and “continuous” extents of inspections and how they compare to “perform” and “observe” inspection tasks.
5. Is familiar with the responsibilities of the QAI regarding the review of material test reports and certifications.
6. Is familiar with the coordinated inspections tasks of the QCI and the QAI.
7. Knows the requirements for inspections of structural steel fabricators.
8. Is familiar with the observation of bolting operations and the provisions of the RCSC Specification.
9. Understands when the QAI must be on the premises for inspection during the placement of anchor rods and other embedments supporting structural steel.
10. Is familiar with the terminology of Quality Assurance and Quality Control as specified.

**WACEL STRUCTURAL STEEL INSPECTOR
SKILLS MATRIX
(MAY 2023)**

Skill	Level 1	Level 2
1. Review approved structural drawings, specifications, shop fabrication drawings, and field erection drawings.	X	X
2. Structural Shapes, Properties, and Tolerances.	X	X
3. Anchor Rods and Column Bases.	X	X
4. Structural Steel Erection and Erection Tolerances.	X	X
5. Bolted Connections.	X	X
6. Post-Installed Anchors.	X	X
7. Basic Welded Connections (single pass fillet welds NTE 5/16") and Welder Qualifications/ Certifications.	X	X
8. Shear/Nelson Studs.	X	X
9. Steel and Composite Decks.	X	X
10. Steel Joists, Joist Girders.	X	X
11. Cold-Formed Steel Structural Framing.	X	X
12. Reporting and Documentation of Non-conforming Items.	X	X
13. IBC's Special Inspection Program and QC/QA requirements of Chapter N, AISC 360.	X	X
14. CWI or equivalent.		X
15. Steel Fabricator Inspections.		TBD
16. Pre-cast Connection Inspections.		TBD

Minimal Qualifications:

1. Level I Structural Steel Inspector: certification of basic skills in accordance with the Level I Study Guide.

2. Level II Structural Steel Inspector: certification at the Level I level and successful completing of the AWS Certified Welding Inspector (CWI) examination or equivalent.