Chapter 17: Structural Tests and Special Inspections

General Comments

In this chapter, the code sets minimum quality standards for the acceptance of materials used in building construction. It also establishes requirements for special inspections, quality assurance and structural observations and load testing.

Section 1701 contains the scope statement and the general statement for new and used materials.

The definitions of terms primarily related to this chapter are in Section 1702.

Section 1703 addresses the approval process.

Special inspections that are required are specified in Section 1704.

Section 1705 includes the quality assurance requirements based on the seismic design category of the structure.

Quality assurance requirements based on wind speed and wind exposure classification are in Section 1706.

Section 1707 contains the special inspection requirements based on the seismic design category of the structure.

Structural testing for seismic resistance is addressed in Section 1708.

Section 1709 establishes when structural observation by a registered design professional is required for high-seismic and high-wind areas.

The general requirements for determining the design strengths of materials are in Section 1710.

Section 1711 provides for an alternative test procedure in the absence of approved standards.

Provisions for a test load are addressed in Section 1712.

Section 1713 includes requirements for field load testing of a structure.

Preconstruction load testing of materials and methods of construction that are not capable of being designed by an approved analysis is covered by Section 1714.

Section 1715 includes specific material and test standards.

Chapter 17 provides information regarding the evaluation, inspection and approval process for any material or system proposed for use as a component of a structure. These are general requirements that expand on the requirements of Chapter 1 relating to the roles and responsibilities of the building official regarding approval of building components. Additionally, the chapter includes general requirements relating to the roles and responsibilities of the owner, contractor, special inspectors and architects or engineers.

Purpose

This chapter provides procedures and criteria for: testing materials or assemblies, labeling materials, systems and assemblies and special inspections of structural assemblies.

SECTION 1701 GENERAL

1701.1 Scope. The provisions of this chapter shall govern the quality, workmanship and requirements for materials covered. Materials of construction and tests shall conform to the applicable standards listed in this code.

❖ This chapter gives provisions for quality, workmanship, testing and labeling of all materials used in the construction of buildings and structures. In general, all construction materials and tests must conform to the applicable standards listed in the code. This chapter provides requirements for materials and tests when there are no applicable standards; specific tests and standards are referenced in other chapters of the code. Additionally, this chapter provides basic requirements for labeling construction materials and assemblies, and for special inspections of structural systems and components.

1701.2 New materials. New building materials, equipment, appliances, systems or methods of construction not provided for in this code, and any material of questioned suitability proposed for use in the construction of a building or structure, shall be subjected to the tests prescribed in this chapter and in the approved rules to determine character, quality and limitations of use.

❖ Testing is required to be performed on materials that are not specifically provided for in the code. For example, the manufacturer of a sandwich panel consisting of aluminum skins and a foam plastic core wishes to use this panel as an exterior weather covering. The material does not conform to any of the standards referenced in Chapter 14, so an appropriate test protocol must be developed. The same provision for acceptance of alternative materials is already given in Section 104.11. That section provides a strong, definitive statement for performance requirements for alternative materials, requiring the proposed alternative to be equivalent to that

prescribed by the code in quality, strength, effectiveness, durability and safety. Section 1701.2 simply reasserts that alternative materials (new materials) may be used, as long as the performance characteristics and quality can be established.

1701.3 Used materials. The use of second-hand materials that meet the minimum requirements of this code for new materials shall be permitted.

❖ Materials and assemblies may be reused, provided that they meet the requirements of the code for new materials (see Section 104.9.1 of the code regarding reuse of materials and equipment). Caution should be exercised in approving a used material for reuse. The applicable material standards must be consulted to determine if certain reuses are prohibited and to determine the characteristics of the used material that must be carefully checked before reuse is approved.

One example is a high-strength structural steel bolt. Reuse of the bolt is specifically prohibited by the AISC ASD standard. Even a piece of structural steel, such as a wide flange, would need to be carefully checked to determine that dimensional tolerances for a new piece of structural steel are met (see ASTM A 6 and A 36).

SECTION 1702
DEFINITIONS

1702.1 General. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

❖ This section contains definitions of terms that are associated with the subject matter of this chapter. It is important to emphasize that these terms are not exclusively related to this chapter, but are applicable everywhere the term is used in the code.

Definitions of terms can help in the understanding and application of the code requirements. The purpose for including these definitions within this chapter is to provide more convenient access to them without having to refer back to Chapter 2. For convenience, these terms are also listed in Chapter 2 with a cross reference to this section.

The use and application of all defined terms, including those defined herein, are set forth in Section 201.

APPROVED AGENCY. An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.

❖ In order to identify the basic criteria or to understand what agencies are being referred to in Section 1703, there is a need to define the term "approved agency." The word "approved" means "acceptable to the building official" (see the definition of "Approved" in Section 202). The basis for approval of an agency for a particular activity by the building official may include, but is not necessarily limited to, the capacity and capability of the agency to perform the work in accordance with Section 1704 and other applicable sections. This is typically done through review of the résumés and references of the agency and its personnel.

APPROVED FABRICATOR. An established and qualified person, firm or corporation approved by the building official pursuant to Chapter 17 of this code.

❖ An approved fabricator is one who has received approval to perform work without a code-required special inspection. The approval is based upon review of the fabricator's written procedural and quality-control manuals and periodic auditing of fabrication practices by an approved special inspection agency.

CERTIFICATE OF COMPLIANCE. A certificate stating that materials and products meet specified standards or that work was done in compliance with approved construction documents.

❖ A certificate of compliance is a document issued by a supplier of materials and products that certifies they meet the specified requirements.

FABRICATED ITEM. Structural, load bearing or lateral load-resisting assemblies consisting of materials assembled prior to installation in a building or structure, or subjected to operations such as heat treatment, thermal cutting, cold working or reforming after manufacture and prior to installation in a building or structure. Materials produced in accordance with standard specifications referenced by this code, such as rolled structural steel shapes, steel-reinforcing bars, masonry units and plywood sheets, shall not be considered "fabricated items."

❖ The term "fabricated items" can easily be misinterpreted to encompass a number of items for which the code does not intend special inspections; therefore, the term is defined to clarify the intent of the code (see Section 1704).

INSPECTION CERTIFICATE. An identification applied on a product by an approved agency containing the name of the manufacturer, the function and performance characteristics, and the name and identification of an approved agency that indicates that the product or material has been inspected and evaluated by an approved agency (see Section 1703.5 and "Label," "Manufacturer's Designation" and "Mark").

❖ An inspection certificate is an identification applied to a product indicating that the individual product has been inspected by a third-party agency. The identification should include three items:

1. The name of the manufacturer;
2. The function and performance characteristics of the product; and
3. The name of the approved agency completing the inspection and evaluation for the product.

Note that the requirements for a "label" (see Section 1702 for the definition of "Label") differ from those of an

inspection certificate. A label is issued by a third-party inspection agency that performs periodic inspections, while an inspection certificate is issued for the product at the time of inspection. The issuance of inspection certificates is an ongoing procedure.

LABEL. An identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics of the product or material, and the name and identification of an approved agency and that indicates that the representative sample of the product or material has been tested and evaluated by an approved agency (see Section 1703.5 and "Inspection Certificate," "Manufacturer's Designation" and "Mark").

❖ A label is used to delineate materials and assemblies that are required to bear the identification of the manufacturer, as well as a third-party quality control agency. The quality control agency allows the use of its label based on periodic audits and inspections of the manufacturer's plant. The code contains specific requirements for labeling (see commentary, Section 1703.5).

MANUFACTURER'S DESIGNATION. An identification applied on a product by the manufacturer indicating that a product or material complies with a specified standard or set of rules (see also "Inspection Certificate," "Label" and "Mark").

❖ This represents terminology for a manufacturer's self-certification that a product complies with a given standard (see commentary, Section 1703.4).

MARK. An identification applied on a product by the manufacturer indicating the name of the manufacturer and the function of a product or material (see also "Inspection Certificate," "Label" and "Manufacturer's Designation").

❖ A mark represents the manufacturer's identification placed on a product, stating who made the product and describing its function. There is, however, no certification of compliance to any particular standard and no third-party quality control (see commentary, Section 1703.4).

SPECIAL INSPECTION. Inspection as herein required of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards (see Section 1704).

❖ This category of inspection is intended to include those material connections or installations that require a special level of knowledge and attention. For example, special inspections are required for the installation of high-strength bolts, welded connections, concrete reinforcement, prestressed concrete, fabrication of laminated wood structural elements and pile installations to comply with the contract documents and the standards under which they are assembled.

SPECIAL INSPECTION, CONTINUOUS. The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

❖ Continuous special inspection requires full-time monitoring, by a special inspector, of the work designated by the code or the quality assurance plan as requiring continuous inspection.

SPECIAL INSPECTION, PERIODIC. The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.

❖ Periodic special inspection requires part-time monitoring, by a special inspector, of the work designated by the code or the quality assurance plan as requiring periodic inspection.

SPRAYED FIRE-RESISTANT MATERIALS. Cementitious or fibrous materials that are spray-applied to provide fire-resistant protection of the substrates.

❖ The cementitious or fibrous material is pneumatically projected onto a surface such that the density, thickness and cohesion/adhesion of the material will provide fire resistance to the surface.

STRUCTURAL OBSERVATION. The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant construction stages and at completion of the structural system. Structural observation does not include or waive the responsibility for the inspection required by Section 109, Section 1704 or other sections of this code.

❖ The registered design professional in responsible charge is required to visit the site to visually determine general conformance to the approved construction documents. Structural observation is in addition to and does not substitute for any required inspections by Section 109, 1704 or other sections of the code.

SECTION 1703
APPROVALS

1703.1 Approved agency. An approved agency shall provide all information as necessary for the building official to determine that the agency meets the applicable requirements.

❖ This section specifies the information that an approved agency must provide to the building official to enable him or her to determine if the agency meets the applicable requirements.

1703.1.1 Independent. An approved agency shall be objective and competent. The agency shall also disclose possible conflicts of interest so that objectivity can be confirmed.

❖ As part of the basis for a building official's approval of a particular inspection agency, the agency must demonstrate its objectivity and competence. The judgement of

objectivity is linked to the financial and fiduciary independence of the agency. The competence of the agency is judged by its experience and organization, and the experience of its personnel.

For example, suppose that ACME Agency is the inspection agency employed by Builder's, Inc. for factory-built fireplaces. During investigation of the agency, it is discovered that ACME and Builder's are subsidiaries of the same parent company, Conglomerate, Inc. The inspection agency and the manufacturer clearly have a relationship that is undesirable from the standpoint of independence.

1703.1.2 Equipment. An approved agency shall have adequate equipment to perform required tests. The equipment shall be periodically calibrated.

❖ As part of judging the ability of a testing or inspection agency, the building official should determine that the agency has the proper equipment to perform the required tests or inspections.

1703.1.3 Personnel. An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests and/or inspections.

❖ The competence of an inspection or testing agency is also based on the experience and background of its personnel. For example, if 10 engineering graduates form an agency, the building official should question whether or not this newly formed agency is sufficiently experienced to perform the tests.

If the services being provided by the inspection agency or test agency come within the purview of the professional registration laws of the state in which the building is being constructed, the building official must request evidence that the personnel are qualified to perform the work in accordance with this professional registration law as well.

1703.2 Written approval. Any material, appliance, equipment, system or method of construction meeting the requirements of this code shall be approved in writing after satisfactory completion of the required tests and submission of required test reports.

❖ In order to have a documented record of the approval and the basis for it, including any conditions or limitations, materials and systems must be approved in writing by the building official. The code also requires the approval to be granted within a reasonable period of time, after all documentation has been satisfactorily developed and submitted, so as to avoid any unnecessary delay in completion of construction.

1703.3 Approved record. For any material, appliance, equipment, system or method of construction that has been approved, a record of such approval, including the conditions and limitations of the approval, shall be kept on file in the building official's office and shall be open to public inspection at appropriate times.

❖ Written approvals must be kept on file by the building official, and be available and open to the public. This provides reasonable access to the records on approvals of materials and systems should there be any subsequent investigation or further evaluation.

1703.4 Performance. Specific information consisting of test reports conducted by an approved testing agency in accordance with standards referenced in Chapter 35, or other such information as necessary, shall be provided for the building official to determine that the material meets the applicable code requirements.

❖ When conformance to the code is predicated on the performance and quality of materials, the building official must require the submittal of testing reports from an approved agency. In the absence of such reports, the building official must accept specific information and details that prove compliance with the intent of the applicable code requirements.

1703.4.1 Research and investigation. Sufficient technical data shall be submitted to the building official to substantiate the proposed use of any material or assembly. If it is determined that the evidence submitted is satisfactory proof of performance for the use intended, the building official shall approve the use of the material or assembly subject to the requirements of this code. The cost offsets, reports and investigations required under these provisions shall be paid by the permit applicant.

❖ This section is usually used in conjunction with Section 104.11 when analysis of any construction material, such as new and innovative materials, is required to determine code compliance. The analysis is based entirely upon technical data. All costs of testing and investigations must be paid by the applicant.

1703.4.2 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

❖ Evaluation reports prepared by approved agencies, such as those published by organizations affiliated with model code groups, may be accepted as part of the information needed by the building official to form the basis for approval. Such reports can supplement the building department resources by eliminating the need for the building official to conduct a detailed analysis or each new product, material or system. It is critically important that such material be truly objective and credible and not consist merely of manufacturer's brochures or similar proprietary information. It is also important to note that when the building official is utilizing research reports in evaluating compliance with the code, such as those issued by organizations affiliated with model code groups, he or she is not mandated to approve these re

search reports just because the code is the legally adopted building code in the jurisdiction. These reports are not code text; they are advisory only and intended for technical reference.

1703.5 Labeling. Where materials or assemblies are required by this code to be labeled, such materials and assemblies shall be labeled by an approved agency in accordance with Section 1703. Products and materials required to be labeled shall be labeled in accordance with the procedures set forth in Sections 1703.5.1 through 1703.5.3.

❖ This section provides requirements for third-party inspection of a manufacturer of a material or assembly when the code says that the material or assembly must be labeled. The materials or assemblies required to be labeled are given in other chapters of the code and the *International Mechanical Code®* (IMC®), *International Fire Code®* (IFC®) and *International Plumbing Code®* (IPC®). Labeling provides a readily available source of information that is useful for field inspection of installed products. The label identifies the product or material and provides other information that can be investigated further if there is any question as to its suitability for the specific installation.

Some examples are gas appliances, fire doors, prefabricated construction (when the building official does not inspect it), electrical appliances, glass, factory-built fireplaces, plywood and other wood members when used structurally, lumber and foam plastics.

1703.5.1 Testing. An approved agency shall test a representative sample of the product or material being labeled to the relevant standard or standards. The approved agency shall maintain a record of the tests performed. The record shall provide sufficient detail to verify compliance with the test standard

❖ As a basis for the allowed use of an agency's label, the agency is required to perform testing on the material or product in accordance with the standard referenced by the code. For example, Section 903.1 of the IMC requires that factory-built fireplaces be tested in accordance with the referenced standard UL 127. This section states that factory-built fireplaces are required to be listed and labeled by an approved agency.

1703.5.2 Inspection and identification. The approved agency shall periodically perform an inspection, which shall be in-plant if necessary, of the product or material that is to be labeled. The inspection shall verify that the labeled product or material is representative of the product or material tested.

❖ The approved agency whose label is to be applied to a product must perform periodic inspections. The primary objective of these inspections is to determine that the manufacturer is, indeed, making the same product that was tested. For example, using the factory-built fireplace discussed in the commentary to Section 1703.5.1, if the fire chamber wall in the test was $^3/_8$-inch-thick (9.5 mm) steel, the inspection agency must check to see that this thickness is being used. If the manufacturer has decided to use $^1/_4$-inch (6.4 mm) steel, then the inspection agency would be forced to withdraw the use of its label and listing.

1703.5.3 Label information. The label shall contain the manufacturer's or distributor's identification, model number, serial number, or definitive information describing the product or material's performance characteristics and approved agency's identification.

❖ This section states what information is required on a label (see Figure 1703.5.3). The purpose of this is so that there will be sufficient information for the inspector to determine that the installed product is the same as that which was approved during plan review.

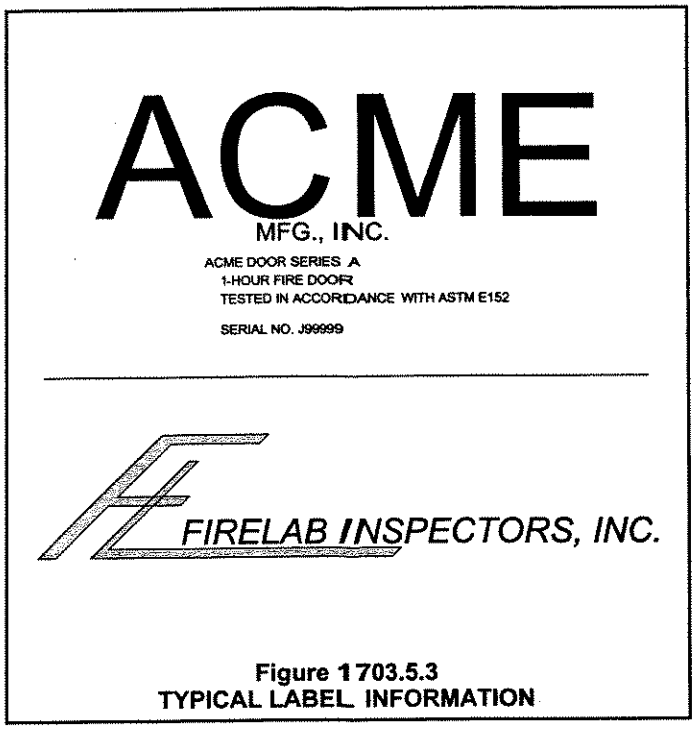

Figure 1703.5.3
TYPICAL LABEL INFORMATION

1703.6 Heretofore approved materials. The use of any material already fabricated or of any construction already erected, which conformed to requirements or approvals heretofore in effect, shall be permitted to continue, if not detrimental to life, health or safety to the public.

❖ If a material or system had been approved before the code took effect, it can continue to be used as long as it can be shown that the material or system is not detrimental to the health or safety of the building occupants or the public. In other words, the code is not retroactive.

1703.7 Evaluation and follow-up inspection services. Where structural components or other items regulated by this code are not visible for inspection after completion of a prefabricated assembly, the permit applicant shall submit a report of each prefabricated assembly. The report shall indicate the complete details of the assembly, including a description of the assembly and the assembly's components, the basis upon which the as-

sembly is being evaluated, test results and similar information, and other data as necessary for the building official to determine conformance to this code. Such a report shall be approved by the building official.

❖ As an alternative to physical inspection by the building official in the plant or location where prefabricated components are manufactured, such as modular homes, trusses, etc., the building official has the option of accepting an evaluation report from an approved agency detailing such inspections.

1703.7.1 Follow-up inspection. The permit applicant shall provide for special inspections of fabricated items in accordance with Section 1704.2.

❖ The owner is required to provide special inspections of fabricated assemblies at the fabrication plant in accordance with Section 1704.2.

1703.7.2 Test and inspection records. Copies of necessary test and inspection records shall be filed with the building official.

❖ All testing and inspection records related to a fabricated assembly must be filed with the building official so as to maintain a complete and legal record of the assembly and erection of the building.

SECTION 1704
SPECIAL INSPECTIONS

1704.1 General. Where application is made for construction as described in this section, the owner or the registered design professional in responsible charge acting as the owner's agent shall employ one or more special inspectors to provide inspections during construction on the types of work listed under Section 1704. The special inspector shall be a qualified person who shall demonstrate competence, to the satisfaction of the building official, for inspection of the particular type of construction or operation requiring special inspection. These inspections are in addition to the inspections specified in Section 109.

Exceptions:

1. Special inspections are not required for work of a minor nature or as warranted by conditions in the jurisdiction as approved by the building official.
2. Special inspections are not required for building components unless the design involves the practice of professional engineering or architecture as defined by applicable state statutes and regulations governing the professional registration and certification of engineers or architects.
3. Unless otherwise required by the building official, special inspections are not required for occupancies in Group R-3 as applicable in Section 101.2 and occupancies in Group U that are accessory to a residential occupancy including, but not limited to, those listed in Section 312.1.

❖ The permit applicant is responsible for hiring the special inspector and must incur all associated costs. According to Section 105.1, the permit applicant may be the owner or authorized agent in connection with the project (see Section 105.1 for further details).

Exceptions to the requirement for special inspections are minor work and work not required to be designed or sealed by a registered design professional, as regulated by the jurisdiction in which the project is located. Occupancies in Group R-3 or U that are accessory to an R-3 occupancy are typically not required to be designed by a registered design professional; however, this is not true in all cases, with Group R-3 and accessory Group U occupancies being specifically excluded.

It should be noted that Exception 1 does not mean that the inspections listed are not required. It only means that they are not required to be made by a special inspector. Additionally, Exception 1 refers to "conditions in the jurisdiction" as a possible exception. The primary "condition" envisioned is one in which the jurisdiction has the resources and skills to perform the inspection tasks, instead of a special inspector. This exception should not be interpreted as one that can be invoked by the permit applicant. A local jurisdiction should not be obligated to invoke this exception. The purpose of this exception is merely to allow jurisdictions to continue doing inspections if they so desire.

Exception 2 eliminates the special inspection requirement for projects where a design professional is not required. The type of projects that do not require a design professional varies from state to state.

1704.1.1 Building permit requirement. The permit applicant shall submit a statement of special inspections prepared by the registered design professional in responsible charge in accordance with Section 106.1 as a condition for permit issuance. This statement shall include a complete list of materials and work requiring special inspections by this section, the inspections to be performed and a list of the individuals, approved agencies or firms intended to be retained for conducting such inspections.

❖ The applicant must submit for approval a detailed outline of the special inspection program, including the building plans and specifications, before issuance of the building permit. This section places the burden of identifying which materials, components and work require special inspections on the permit applicant. This detailed outline, or statement of special inspections, is required to be prepared by the registered design professional responsible for the building or structure. This is because the special inspections statement relates directly to the construction and design documents, which are the responsibility of the registered design professional.

This section also details the areas to be addressed in the statement. A complete list of materials and work requiring special inspections, the types of inspections and inspection agencies or firms must be provided to the building official. The qualifications and credentials of such individuals, agencies or firms should be submitted for review by the building official.

1704.1.2 Report requirement. Special inspectors shall keep records of inspections. The special inspector shall furnish inspection reports to the building official, and to the registered design professional in responsible charge. Reports shall indicate that work inspected was done in conformance to approved construction documents. Discrepancies shall be brought to the immediate attention of the contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the building official and to the registered design professional in responsible charge prior to the completion of that phase of the work. A final report documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted at a point in time agreed upon by the permit applicant and the building official prior to the start of work.

❖ Records of each inspection must be submitted to the building official so as to compile a complete legal record of the project. These records must include all inspections made, violations and discrepancies. Before a certificate of occupancy is issued, a final report must be submitted indicating that all special inspections have been made and all discrepancies resolved or removed in order to show compliance with the applicable code requirements. It is the responsibility of the special inspector to document and submit inspection records to the building official and to the registered design professional in responsible charge of the project.

1704.2 Inspection of fabricators. Where fabrication of structural load-bearing members and assemblies is being performed on the premises of a fabricator's shop, special inspection of the fabricated items shall be required by this section and as required elsewhere in this code.

❖ Inspection of in-plant fabrications and the requirements for special in-plant inspections are addressed herein. This section should be used in conjunction with Section 1703.7 relating to evaluation and follow-up inspections.

1704.2.1 Fabrication and implementation procedures. The special inspector shall verify that the fabricator maintains detailed fabrication and quality control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards. The special inspector shall review the procedures for completeness and adequacy relative to the code requirements for the fabricator's scope of work.

Exception: Special inspections as required by Section 1704.2 shall not be required where the fabricator is approved in accordance with Section 1704.2.2.

❖ The special inspector is required to verify not only that the fabricator complies with the design details and in-house quality control procedures at the plant, but also its ability to conform to the approved drawings, standards and specifications. An example of this would be an inspection of proper placement and rolling of truss-plate connectors at a wood-truss manufacturing plant. Improper procedures could result in the connectors "popping out" or "peeling back" after the truss is concealed and loaded, thus causing structural failure. Special inspections are not required if an approved independent agency conducts in-house inspections.

1704.2.2 Fabricator approval. Special inspections required by this code are not required where the work is done on the premises of a fabricator registered and approved to perform such work without special inspection. Approval shall be based upon review of the fabricator's written procedural and quality control manuals and periodic auditing of fabrication practices by an approved special inspection agency. At completion of fabrication, the approved fabricator shall submit a certificate of compliance to the building official stating that the work was performed in accordance with the approved construction documents.

❖ Special inspections are not required by the code where the work is done on the premises of an approved fabricator. If the fabricator meets the qualifications described in the code and is approved by the building official, then its quality control procedures are expected to be such that a special inspector is not required for work accomplished in the fabricator's shop.

1704.3 Steel construction. The special inspections for steel elements of buildings and structures shall be as required by Section 1704.3 and Table 1704.3. Where required, special inspection of steel shall also comply with Section 1715.

Exceptions:

1. Special inspection of the steel fabrication process shall not be required where the fabricator does not perform any welding, thermal cutting or heating operation of any kind as part of the fabrication process. In such cases, the fabricator shall be required to submit a detailed procedure for material control that demonstrates the fabricator's ability to maintain suitable records and procedures such that, at any time during the fabrication process, the material specification, grade and mill test reports for the main stress-carrying elements are capable of being determined.
2. The special inspector need not be continuously present during welding of the following items, provided the materials, welding procedures and qualifications of welders are verified prior to the start of the work; periodic inspections are made of the work in progress; and a visual inspection of all welds is made prior to completion or prior to shipment of shop welding.
   2.1. Single pass fillet welds not exceeding $^5/_{16}$ inch (7.9 mm) in size.
   2.2. Floor and roof deck welding.
   2.3. Welded studs when used for structural diaphragm.
   2.4. Welded sheet steel for cold-formed steel framing members such as studs and joists.
   2.5. Welding of stairs and railing systems.

❖ The requirements to be followed by the special inspector for the erection and fabrication of structural steel elements of building construction are described in this section.This section also refers to Table 1704.3 for special

inspection of steel construction.

An exemption is allowed if the fabrication plant does not utilize any facilities or methods that may alter the physical characteristics or properties of the steel members or components, such as welding, thermal cutting or heating operations. The fabricator would, in any case, need to provide evidence that procedures are used that verify that the proper material specification and grade for the main stress-carrying elements are supplied in accordance with the job specifications and shop drawings.

TABLE 1704.3. See page 17-9.

❖ Table 1704.3 lists the types of materials and inspections, the verification required and the referenced standards to be used in evaluating conformance to and code compliance with main stress-carrying elements of steel construction.

1704.3.1 Welding. Welding inspection shall be in compliance with AWS D1.1. The basis for welding inspector qualification shall be AWS D1.1.

❖ The referenced standard for this section is AWS D1.1 from the American Welding Society (AWS). This standard covers 10 areas of welding: general provisions; design of welded connections; workmanship; technique; qualification; inspection; strengthening and repair of existing structures; design of new buildings; and the design of new bridges and new tubular structures. The tables in AWS D1.1 are intended only to provide prequalified joint geometry, such as root opening, angles and clearances, which will permit a qualified welder to deposit sound weld metal.

Weld joints other than those specified by AWS may be qualified, provided that they are tested and qualified in accordance with AWS D1.1.

All prequalified or qualified welds should have a written welding procedure specification prepared by the fabricator, following the detail and outline suggested by AWS D1.1. This specification should be available to the engineer, inspector and building official.

Weld inspectors are also required to be qualified in accordance with AWS D1.1, which references AWS QC1.

1704.3.2 Details. The special inspector shall perform an inspection of the steel frame to verify compliance with the details shown on the approved construction documents, such as bracing, stiffening, member locations and proper application of joint details at each connection.

❖ The special inspector is required to perform an inspection of the entire steel frame to verify compliance with the applicable code requirements and the approved engineering drawings.

1704.3.3 High-strength bolts. Installation of high-strength bolts shall be periodically inspected in accordance with AISC specifications.

❖ Installation and periodic inspection of high-strength (ASTM A 325 or ASTM A 490 or equivalent) bolts must be in accordance with AISC ASD or AISC LRFD.

1704.3.3.1 General. While the work is in progress, the special inspector shall determine that the requirements for bolts, nuts, washers, and paint; bolted parts; and installation and tightening in such standards are met. For bolts requiring pretensioning, the special inspector shall observe the pre-installation testing and calibration procedures when such procedures are required by the installation method or by project plans or specification; determine that all plies of connected materials have been drawn together and properly snugged; and monitor the installation of bolts to verify that the selected procedure for installation is properly used to tighten bolts. For joints required to be tightened only to the snug tight condition, the special inspector need only verify that the connected materials have been drawn together and properly snugged.

❖ Inspection procedures that provide the greatest ensurance that bolts are properly installed and tensioned are provided first by observing the calibration testing of the fasteners using the selected installation procedure, and then by monitoring the work in progress to ensure that the procedure that provided the specified tension is routinely adhered to. When such a program is followed, no further evidence of proper bolt tension is required.

1704.3.3.2 Periodic monitoring. Monitoring of bolt installation for pretensioning is permitted to be performed on a periodic basis when using the turn-of-nut method with matchmarking techniques, the direct tension indicator method, or the alternate design fastener (twist-off bolt) method. Joints designated as snug tight need be inspected only on a periodic basis.

❖ Periodic monitoring by a special inspector is permitted for high-strength bolts installed and tightened by the turn-of-nut method with matchmarking techniques, the direct tension indicator method, the alternate design fastener method or joints designated as snug tight.

1704.3.3.3 Continuous monitoring. Monitoring of bolt installation for pretensioning using the calibrated wrench method or the turn-of-nut method without matchmarking shall be performed on a continuous basis.

❖ Continuous monitoring by a special inspector is required for high-strength bolts installed and tightened by the calibrated wrench method or the turn-of-nut method without matchmarking.

TABLE 1704.3
REQUIRED VERIFICATION AND INSPECTION OF STEEL CONSTRUCTION

VERIFICATION AND INSPECTION	CONTINUOUS	PERIODIC	REFERENCED STANDARD[a]	IBC REFERENCE
1. Material verification of high-strength bolts, nuts and washers:				
a. Identification markings to conform to ASTM standards specified in the approved construction documents.	—	X	Applicable ASTM material specifications; AISC ASD, Section A3.4; AISC LRFD, Section A3.3	—
b. Manufacturer's certificate of compliance required.	—	X	—	—
2. Inspection of high-strength bolting:				
a. Bearing-type connections.	—	X	AISC LRFD Section M2.5	1704.3.3
b. Slip-critical connections.	X	X		
3. Material verification of structural steel:				
a. Identification markings to conform to ASTM standards specified in the approved construction documents.	—	—	ASTM A 6 or ASTM A 568	1708.4
b. Manufacturers' certified mill test reports.	—	—	ASTM A 6 or ASTM A 568	
4. Material verification of weld filler materials:				—
a. Identification markings to conform to AWS specification in the approved construction documents.	—	—	AISC, ASD, Section A3.6; AISC LRFD, Section A3.5	—
b. Manufacturer's certificate of compliance required.	—	—	—	—
5. Inspection of welding: a. Structural steel:	—	—		
1) Complete and partial penetration groove welds.	X	—	AWS D1.1	1704.3.1
2) Multi-pass fillet welds.	X	—		
3) Single-pass fillet welds > $^5/_{16}$"	X	—		
4) Single-pass fillet welds < $^5/_{16}$"	—	X		
5) Floor and deck welds.	—	X	AWS D1.3	—
b. Reinforcing steel:	—	—	AWS D1.4 ACI 318: 3.5.2	1903.5.2
1) Verification of weldability of reinforcing steel other than ASTM A 706.	—	X		
2) Reinforcing steel-resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special reinforced concrete shear walls and shear reinforcement.	X	—		
3) Shear reinforcement.	X	—		
4) Other reinforcing steel.	—	X		
6. Inspection of steel frame joint details for compliance with approved construction documents:		X	—	1704.3.2
a. Details such as bracing and stiffening.	—	—		
b. Member locations.	—	—		
c. Application of joint details at each connection.	—			

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1707.1, Special inspection for seismic resistance.

1704.4 Concrete construction. The special inspections and verifications for concrete construction shall be as required by this section and Table 1704.4.

Exception: Special inspections shall not be required for:

1. Isolated spread concrete footings of buildings three stories or less in height that are fully supported on earth or rock.
2. Continuous concrete footings supporting walls of buildings three stories or less in height that are fully supported on earth or rock where:
   2.1. The footings support walls of light frame construction;
   2.2. The footings are designed in accordance with Table 1805.4.2; or
   2.3. The structural design is based on a f'_c no greater than 2,500 pounds per square inch (psi) (17.2 Mpa).
3. Nonstructural concrete slabs supported directly on the ground, including prestressed slabs on grade, where the effective prestress in the concrete is less than 150 psi (1.03 Mpa).
4. Concrete foundation walls constructed in accordance with Table 1805.5(1), 1805.5(2), 1805.5(3) or 1805.5(4).
5. Concrete patios, driveways and sidewalks, on grade.

❖ This section establishes criteria for special inspections of elements of buildings and structures of concrete construction. Exceptions to the requirements of this section address concrete components that have little or no load-carrying requirements, such as nonstructural slabs on grade, driveways, patios, etc., or footings and foundations that require no reinforcement and carry relatively low loads.

TABLE 1704.4
REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION

VERIFICATION AND INSPECTION	CONTINUOUS	PERIODIC	REFERENCED STANDARD[a]	IBC REFERENCE
1. Inspection of reinforcing steel, including prestressing tendons, and placement.	—	X	ACI 318: 3.5, 7.1-7.7	1903.5, 1907.1, 1907.7, 1914.4
2. Inspection of reinforcing steel welding in accordance with Table 1704.3, Item 5B.	—	—	AWS D1.4 ACI 318: 3.5.2	1903.5.2
3. Inspect bolts to be installed in concrete prior to and during placement of concrete where allowable loads have been increased.	X	—	—	1912.5
4. Verifying use of required design mix.	—	X	ACI 318: Ch. 4, 5.2-5.4	1904, 1905.2-1905.4, 1914.2, 1914.3
5. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	—	ASTM C 172 ASTM C 31 ACI 318: 5.6, 5.8	1905.6, 1914.10
6. Inspection of concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 5.9, 5.10	1905.9, 1905.10, 1914.6, 1914.7, 1914.8
7. Inspection for maintenance of specified curing temperature and techniques.	—	X	ACI 318: 5.11-5.13	1905.11, 1905.13, 1914.9
8. Inspection of prestressed concrete: a. Application of prestressing forces. b. Grouting of bonded prestressing tendons in the seismic-force-resisting system.	 X X	—	ACI 318: 18.20 ACI 318: 18.18.4	—
9. Erection of precast concrete members.	—	X	ACI 318: Ch. 16	—
10. Verification of in-situ concrete strength, prior to stressing of tendons in posttensioned concrete and prior to removal of shores and forms from beams and structural slabs.	—	X	ACI 318: 6.2	1906.2

For SI: 1 inch = 25.4 mm.
a. Where applicable, see also Section 1707.1, Special inspection for seismic resistance.

TABLE 1704.4. See page 17-10.

❖ Required verifications and inspections during concrete construction operations are listed in Table 1704.4. This table lists the types of inspections required and the referenced standards for the placing, curing, prestressing and erection of concrete construction.

1704.4.1 Materials. In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapter 3 of ACI 318, the building official shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapter 3 of ACI 318. Weldability of reinforcement, except that which conforms to ASTM A 706, shall be determined in accordance with the requirements of Section 1903.5.2.

❖ Concrete materials, such as cement, aggregates, admixtures and water, must comply with the standards of Chapter 3 of ACI 318, which regulates materials and addresses specific standards. In the absence of sufficient data or documentation, the building official must require testing in accordance with the standards listed in Chapter 3 of ACI 318.

ASTM A 706 is the standard for reinforcing steel that is weldable, meaning that the chemical composition and manufacturing processes are such that the material is well suited for an acceptable quality of weld. Section 1903.5.2 states that any standard other than ASTM A 706 used for reinforcement material would need to be supplemented for weldability requirements. The intent of this provision is that, where welding of reinforcing steel is required, the steel specified and delivered must be checked for weldability.

1704.5 Masonry construction. Masonry construction shall be inspected and evaluated in accordance with the requirements of this section, depending on the classification of the building or structure or nature of occupancy, as defined by this code (see Table 1604.5 and Section 1617.2).

Exception: Special inspections shall not be required for:

1. Empirically designed masonry, glass unit masonry or masonry veneer designed by Section 2109, 2110 or ACI 530/ASCE 5/TMS 402, Chapters 5, 6 or 7, when they are part of nonessential buildings (see Table 1604.5 and Section 1617.2).
2. Masonry foundation walls constructed in accordance with Table 1805.5(1), 1805.5(2), 1805.5(3) or 1805.5(4).

❖ This section establishes whether special inspection is required, and the necessary level, for masonry construction. This is determined by the design method (empirical versus engineered) and whether or not a structure is classified as an essential facility. These requirements are summarized in Table 1704.5. An essential facility would be an Occupancy Category IV in Table 1604.5 and/or Seismic Use Group III in accordance with Section 1616.2.3. Additionally, masonry foundation walls complying with the prescriptive tables in Section 1805.5 are exempt from special inspection.

TABLE 1704.5
SPECIAL INSPECTION OF MASONRY CONSTRUCTION

	TYPE OF FACILITY			
	Nonessential		Essential	
Design method	Empirical	Engineered	Empirical	Engineered
Special inspection	Exempt	Level 1	Level 1	Level 2

1704.5.1 Empirically designed masonry, glass unit masonry and masonry veneer in essential facilities. The minimum inspection program for masonry designed by Chapter 14, Section 2109 or 2110, or by Chapter 5, 6, or 7 of ACI 530/ASCE 5/TMS 402, in essential facilities listed in Table 1604.5 and Section 1616.2, shall comply with Table 1704.5.1.

❖ This section defines the minimum level of special inspection required for empirically designed masonry, glass unit masonry and masonry veneer in essential facilities (see Table 1704.5.1).

TABLE 1704.5.1. See page 17-12.

❖ The minimum required special inspections and verifications during masonry construction are listed in Table 1704.5.1. This table also lists the required criteria from the code, ACI 530 and ACI 530.1. This table applies to empirically designed masonry in essential facilities and to engineered design in nonessential facilities.

1704.5.2 Engineered masonry in nonessential facilities. The minimum special inspection program for masonry designed by Section 2106, 2107 or 2108, or by chapters other than Chapters 5, 6, or 7 of ACI 530/ASCE 5/TMS 402, in nonessential facilities (see Table 1604.5 and Section 1617.2) shall comply with Table 1704.5.1.

❖ Engineered masonry in nonessential facilities requires special inspection. The minimum special inspections required are listed in Table 1704.5.1.

1704.5.3 Engineered masonry in essential facilities. The minimum special inspection program for masonry designed by Section 2106, 2107 or 2108, or by chapters other than Chapters 5, 6 or 7 of ACI 530/ASCE5/TMS 402, in essential facilities (see Table 1604.5 and Section 1616.2) shall comply with Table 1704.5.3.

❖ Engineered masonry in essential facilities requires special inspection. The minimum special inspections required are listed in Table 1704.5.3.

TABLE 1704.5.3. See page 17-13.

❖ The minimum required special inspections and verifications during masonry construction of engineered design masonry in essential facilities are listed in Table 1704.5.3. This table also lists the required criteria from the code, ACI 530 and ACI 530.1.

TABLE 1704.5.1
LEVEL 1 SPECIAL INSPECTION

INSPECTION TASK	FREQUENCY OF INSPECTION		REFERENCE FOR CRITERIA		
	Continuous during task listed	Periodically during task listed	IBC section	ACI 530/ ASCE 5/TMS 402[a]	ACI 530.1/ ASCE 6/TMS 602[a]
1. As masonry construction begins, the following shall be verified to ensure compliance:					
a. Proportions of site-prepared mortar.	—	X	—	—	Art. 2.6A
b. Construction of mortar joints.		X			Art. 3.3B
c. Location of reinforcement and connectors.		X			Art. 3.4, 3.6A
d. Prestressing technique.	—	X	—	—	Art. 3.6B
e. Grade and size of prestressing tendons and anchorages.	—	X	—	—	Art. 2.4B, 2.4H
2. The inspection program shall verify:					
a. Size and location of structural elements.	—	X	—	—	Art. 3.3G
b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.	—	X	—	Sec. 1.2.2(e), 2.1.4, 3.1.6	—
c. Specified size, grade and type of reinforcement.	—	X	—	Sec. 1.12	Art. 2.4, 3.4
d. Welding of reinforcing bars.	X	—	—	Sec. 2.1.10.6.2 3.2.3.4(b)	—
e. Protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F).	—	X	Sec. 2104.3, 2104.4	—	Art. 1.8C, 1.8D
f. Application and measurement of prestressing force.	—	X	—	—	Art. 3.6B
3. Prior to grouting, the following shall be verified to ensure compliance:					
a. Grout space is clean.	—	X	—	—	Art. 3.2D
b. Placement of reinforcement and connectors and prestressing tendons and anchorages.		X		Sec. 1.12	Art. 3.4
c. Proportions of site-prepared grout and prestressing grout for bonded tendons.		X		—	Art. 2.6B
d. Construction of mortar joints.		X		—	Art. 3.3B
4. Grout placement shall be verified to ensure compliance with code and construction document provisions.	X	—	—	—	Art 3.5
a. Grouting of prestressing bonded tendons.	X	—	—	—	Art. 3.6C
5. Preparation of any required grout specimens, mortar specimens and/or prisms shall be observed.	X	—	Sec. 2105.2.2, 2105.3	—	Art. 1.4
6. Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified.	—	X	—	—	Art. 1.5

For SI: °C = (°F – 32)/1.8.

a. The specific standards referenced are those listed in Chapter 35.

1704.6 Wood construction. Special inspections of the fabrication process of prefabricated wood structural elements and assemblies shall be in accordance with Section 1704.2. Special inspections of site-built assemblies shall be in accordance with Section 1704.1.

❖ The fabrication process of wood structural elements and assemblies (such as wood trusses) that is being performed on the premises of a fabricator's shop must receive special inspection in accordance with Section 1704.2.

1704.6.1 Fabrication of high-load diaphragms. High-load diaphragms using values from Table 2306.3.2 shall be installed with special inspections as indicated in Section 1704.1. The special inspector shall inspect the wood structural panel sheathing to ascertain whether it is of the grade and thickness shown on the approved building plans. Additionally, the special inspector must verify the nominal size of framing members at adjoining panel edges, the nail or staple diameter and length, the number of fastener lines and that spacing between fasteners in each line and at edge margins agrees with the approved building plans.

❖ This section requires special inspection of specific portions of diaphragms that are designed in accordance with Table 2306.3.2. By their very nature, these "high-load" diaphragms are likely to carry more signifi-

TABLE 1704.5.3
LEVEL 2 SPECIAL INSPECTION

INSPECTION TASK	FREQUENCY OF INSPECTION		REFERENCE FOR CRITERIA		
	Continuous during task listed	Periodically during task listed	IBC section	ACI 530/ ASCE 5/ TMS 402[a]	ACI 530.1/ ASCE 6/ TMS 602[a]
1. From the beginning of masonry construction, the following shall be verified to ensure compliance:					
a. Proportions of site-mixed mortar, grout and prestressing grout for bonded tendons.	—	X	—	—	Art. 2.6A
b. Placement of masonry units and construction of mortar joints.	—	X	—	—	Art. 3.3B
c. Placement of reinforcement, connectors and prestressing tendons and anchorges.	—	X	—	Sec. 1.12	Art. 3.4, 3.6 A
d. Grout space prior to grouting.	X	—	—	—	Art. 3.2D
e. Placement of grout.	X	—	—	—	Art. 3.5
f. Placement of prestressing grout.	X	—	—	—	Art. 3.6C
2. The inspection program shall verify:					
a. Size and location of structural elements.	—	X	—	—	Art. 3.3G
b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.	X	—	—	Sec. 1.2.2(e), 2.1.4, 3.1.6	—
c. Specified size, grade and type of reinforcement.		X	—	Sec. 1.12	Art. 2.4, 3.4
d. Welding of reinforcement.	X	—	—	Sec.2.1.10.6.2, 3.2.3.4(b)	—
e. Protection of masonry during cold weather and (temperature below 40°F) or hot weather (temperature above 90°F).	—	X	Sec. 2104.3, 2104.4	—	Art. 1.8C, 1.8D
f. Application and measurement of prestressing force.	X	—	—	—	Art. 3.6B
3. Preparation of any required grout specimens, mortar specimens and/or prisms shall be observed.	X	—	Sec. 2105.2.2, 2105.3	—	Art. 1.4
4. Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified.	—	X	—	—	Art 1.5

For SI: °C = (°F – 32)/1.8.

a. The specific standards referenced are those listed in Chapter 35.

cant wind or seismic loads, making it necessary to perform special inspection.

1704.7 Soils. The special inspections for existing site soil conditions, fill placement and load-bearing requirements shall follow Sections 1704.7.1 through 1704.7.3. The approved soils report, required by Section 1802.2, shall be used to determine compliance.

Exception: Special inspections not required during placement of fill less than 12 inches (305 mm) deep.

❖ The increasing use of prepared fill as a load-bearing soil strata has established the need to make specific mention of this construction in the special inspection requirements. The load-bearing capacity of the supporting soil has a significant impact on the structural integrity of any building. The amount of compaction and the methods vary depending on the particular design. Use of proper compaction, lift and density, however, is critical to achieving the desired bearing capacity.

1704.7.1 Site preparation. Prior to placement of the prepared fill, the special inspector shall determine that the site has been prepared in accordance with the approved soils report.

❖ The first important step for prepared fill is to verify that the site preparation meets specified requirements, including proper excavation depth, removal of all deleterious material and any other special requirements that the soils engineer deems necessary for the design.

1704.7.2 During fill placement. During placement and compaction of the fill material, the special inspector shall determine that the material being used and the maximum lift thickness comply with the approved report, as specified in Section 1803.4.

❖ The fill placement operation is clearly an item that falls into the special inspection category. Without observing and documenting that the proper material is used and the specified compaction techniques and lifts are employed, the load-bearing capacity may not be consistent with the design requirements.

1704.7.3 Evaluation of in-place density. The special inspector shall determine, at the approved frequency, that the in-place dry density of the compacted fill complies with the approved report.

❖ A major factor in the design of the fill is the in-place density. This evaluation is needed so that the compaction methods result in adequate soil-bearing capacity.

1704.8 Pile foundations. A special inspector shall be present when pile foundations are being installed and during tests. The special inspector shall make and submit to the building official records of the installation of each pile and results of load tests. Records shall include the cutoff and tip elevation of each pile relative to a permanent reference.

❖ Special inspections of pile foundations must conform to the criteria and standards of Section 1807.2, which establishes inspection procedures and record submittal information.

1704.9 Pier foundations. Special inspection is required for pier foundations for buildings assigned to Seismic Design Category C, D, E or F in accordance with Section 1616.3.

❖ For structures located in Seismic Design Category C, D, E or F, the pier foundations will typically be of reinforced concrete that is subject to special inspections in accordance with Section 1704.4. It should be noted, however, that the exceptions in Section 1704.4 do not apply to pier foundations in Seismic Design Category C, D, E or F.

1704.10 Wall panels and veneers. Special inspection is required for exterior and interior architectural wall panels and the anchoring of veneers for buildings assigned to Seismic Design Category E or F in accordance with Section 1616.3. Special inspection of such masonry veneer shall be in accordance with Section 1704.5.

❖ A building frame is often adequately designed to withstand an earthquake, but the veneer connections may not adequately perform in the event of an earthquake. Falling bricks, glass or other materials can cause serious injury or damage. Buildings in Seismic Design Category E or F are in the most severe earthquake category.

1704.11 Sprayed fire-resistant materials. Special inspections for sprayed fire-resistant materials applied to structural elements and decks shall be in accordance with Sections 1704.11.1 through 1704.11.5. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents.

❖ To ensure that a sprayed fire-resistant material, or SFRM as it is commonly referred to, performs as intended by the manufacturer, certain conditions are required to be met during its application. The conditions include: temperature at time of application; substrate conditions; protection provided; and thickness and density of material. These conditions must be checked and verified at the time of, or prior to, the application of the SFRM. This section stipulates that special inspections are required in accordance with Sections 1704.11.1 through 1704.11.5.

1704.11.1 Structural member surface conditions. The surfaces shall be prepared in accordance with the approved fire-resistance design and the approved manufacturer's written instructions. The prepared surface of structural members to be sprayed shall be inspected before the application of the sprayed fire-resistant material.

❖ The integrity of an SFRM system depends, foremost, on the conditions of the surface of the steel member to which it is to be applied. The system must be fully adhered to the surface for proper performance, in accordance with design values.

1704.11.2 Application. The substrate shall have a minimum ambient temperature before and after application as specified in the approved manufacturer's written instructions. The area for

application shall be ventilated during and after application as required by the approved manufacturer's written instructions.

❖ During application of SFRMs, and immediately thereafter during cure of the material, several items must be controlled, including ambient temperature during the application and temperature of the substrate and the sprayed fire-resistant materials. Temperature control is important to determine that the necessary chemical reactions needed to make a particular material bond to the steel surfaces and hold together, do, in fact, happen. The minimum or maximum temperatures necessary for proper bond and cure depend on the specific type of material. The scope of the special inspection also includes the proper ventilation for curing.

1704.11.3 Thickness. The average thickness of the sprayed fire-resistant materials applied to structural elements shall not be less than the thickness required by the approved fire-resistance design. Individual measured thickness, which exceeds the thickness specified in a design by $^1/_4$ inch (6.4 mm) or more shall be recorded as the thickness specified in the design plus $^1/_4$ inch (6.4 mm). For design thicknesses 1 inch (25 mm) or greater, the minimum allowable individual thickness shall be the design thickness minus $^1/_4$ inch (6.4 mm). For design thicknesses less than 1 inch (25 mm), the minimum allowable individual thickness shall be the design thickness minus 25 percent. Thickness shall be determined in accordance with ASTM E 605. Samples of the sprayed fire-resistant materials shall be selected in accordance with Sections 1704.11.3.1 and 1704.11.3.2.

❖ For the system to provide the required design fire-resistance rating, it must be applied at the appropriate thickness. The required sampling provided for in Sections 1704.11.3.1 and 1704.11.3.2 is based on ASTM E 605. This standard also provides testing methods that are commonly used by the industry.

1704.11.3.1 Floor, roof and wall assemblies. The thickness of the sprayed fire-resistant material applied to floor, roof and wall assemblies shall be determined in accordance with ASTM E 605, taking the average of not less than four measurements for each 1,000 square feet (93 m^2) of the sprayed area on each floor or part thereof.

❖ Sampling of a SFRM for membrane components (floors, roofs or walls) is based on the square footage of the components. The size of the sample and the amount of area per sample are taken from ASTM E 605.

1704.11.3.2 Structural framing members. The thickness of the sprayed fire-resistant material applied to structural members shall be determined in accordance with ASTM E 605. Thickness testing shall be performed on not less than 25 percent of the structural members on each floor.

❖ Sampling of a SFRM for structural elements is based on the number of structural elements. Again, sample size and number of elements represented by one sample are taken from ASTM E 605.

1704.11.4 Density. The density of the sprayed fire-resistant material shall not be less than the density specified in the approved fire-resistant design. Density of the sprayed fire-resistant material shall be determined in accordance with ASTM E 605.

❖ The density of a SFRM will have an impact on the fire-resistance rating of the system. Therefore, it is important that the density of the material be measured to verify that the product is as designed. The sampling requirements given are the same as those for thickness measurements in Sections 1704.11.3.1 and 1704.11.3.2. The required method of determining density is provided in ASTM E 605.

1704.11.5 Bond strength. The cohesive/adhesive bond strength of the cured sprayed fire-resistant material applied to structural elements shall not be less than 150 pounds per square foot (psf) (7.18 kN/m^2). The cohesive/adhesive bond strength shall be determined in accordance with the field test specified in ASTM E 736 by testing in-place samples of the sprayed fire-resistant material selected in accordance with Sections 1704.11.5.1 and 1704.11.5.2.

❖ Bond strength of the material is an essential variable in the design equation for an appropriate fire-resistance rating of a SFRM. A minimum cohesive/adhesive bond strength of 150 pounds per square foot (psf) (7.18 kN/m^2) is required in this section based on the American Institute of Architects (AIA) Master Specification and the recommendations of the General Services Administration (GSA) for durability and serviceability of the material.

1704.11.5.1 Floor, roof and wall assemblies. The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from each floor, roof and wall assembly at the rate of not less than one sample for every 10,000 square feet (929 m^2) or part thereof of the sprayed area in each story.

❖ The sampling rate for bond in this section is less than the samples required for thickness and density, since the thickness and density samples minimize the need for bond strength sampling.

1704.11.5.2 Structural framing members. The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from beams, girders, joists, trusses and columns at the rate of not less than one sample for each type of structural framing member for each 10,000 square feet (929 m^2) of floor area or part thereof in each story.

❖ The bond strength sampling rate in this section is the same as that indicated in Section 1704.11.5.1 for floor, roof and wall assemblies.

1704.12 Exterior insulation and finish systems (EIFS). Special inspections shall be required for all EIFS applications.

Exceptions:

1. Special inspections shall not be required for EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior.
2. Special inspections shall not be required for EIFS applications installed over masonry or concrete walls.

❖ Special inspections are required for all EIFS installations except for the two exceptions in this section. The first exception recognizes that EIFS, which are installed over a water-resistive barrier and incorporate flashings at penetrations and terminations and a means of drainage to the exterior, afford a built-in redundancy to water penetration that makes the need for special inspections less critical.

The second exception recognizes that concrete and masonry substrates are relatively durable and the exposure to moisture in wall conditions does not necessarily have a detrimental effect on these materials.

1704.13 Special cases. Special inspections shall be required for proposed work that is, in the opinion of the building official, unusual in its nature, such as, but not limited to, the following examples:

1. Construction materials and systems that are alternatives to materials and systems prescribed by this code.
2. Unusual design applications of materials described in this code.
3. Materials and systems required to be installed in accordance with additional manufacturer's instructions that prescribe requirements not contained in this code or in standards referenced by this code.

❖ This section requires special inspections for proposed work that is unique and not specifically addressed in the code or in standards referenced by the code. For example, a designer chooses to utilize a new type of wood-laminated beam system in lieu of standard steel beam construction. Because the laminated beam is a new product, the inspector must rely on load tables, connection details and bearing length charts from the manufacturer, provided that the system is previously approved for installation by the building official.

1704.14 Special inspection for smoke control. Smoke control systems shall be tested by a special inspector.

❖ This section requires that all smoke control systems be tested by special inspection.

1704.14.1 Testing scope. The test scope shall be as follows:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements, and detection and control verification.

❖ Testing of the smoke control system must be performed in at least two stages: the first testing is during erection of ductwork and prior to concealment, and the second testing is before the certificate of occupancy is issued. Both stages require testing by a special inspection agency to show compliance with the requirement of this section.

1704.14.2 Qualifications. Special inspection agencies for smoke control shall have expertise in fire-protection engineering, mechanical engineering and certification as air balancers.

❖ An approved special inspection agency of smoke control systems must have expertise and certification in fire protection engineering, mechanical engineering or air balancing.

SECTION 1705
QUALITY ASSURANCE FOR SEISMIC RESISTANCE

1705.1 Scope. A quality assurance plan for seismic requirements shall be provided in accordance with Section 1705.2 for the following:

1. The seismic-force-resisting systems in structures assigned to Seismic Design Category C, D, E or F, in accordance with Section 1616.
2. Designated seismic systems in structures assigned to Seismic Design Category D, E or F.
3. The following additional systems in structures assigned to Seismic Design Category C:
   - 3.1. Heating, ventilating and air-conditioning (HVAC) ductwork containing hazardous materials and anchorage of such ductwork.
   - 3.2. Piping systems and mechanical units containing flammable, combustible or highly toxic materials.
   - 3.3. Anchorage of electrical equipment used for emergency or standby power systems.
4. The following additional systems in structures assigned to Seismic Design Category D:
   - 4.1. Systems required for Seismic Design Category C.
   - 4.2. Exterior wall panels and their anchorage.
   - 4.3. Suspended ceiling systems and their anchorage.
   - 4.4. Access floors and their anchorage.
   - 4.5. Steel storage racks and their anchorage, where the factor, *Ip*, determined in Section 9.6.1.5 of ASCE 7, is equal to 1.5.
5. The following additional systems in structures assigned to Seismic Design Category E or F:
   - 5.1. Systems required for Seismic Design Categories C and D.

5.2. Electrical equipment.

Exceptions:

1. A quality assurance plan is not required for structures designed and constructed in accordance with the conventional construction provisions of Section 2308.
2. A quality assurance plan is not required for structures designed and constructed in accordance with the following:
   2.1. The structure is constructed of light wood framing or light framed cold-formed steel; the design spectral response acceleration at short periods, S_{DS}, as determined in Section 1615.1, does not exceed 0.5g, and the height of the structure does not exceed 35 feet (10 668 mm) above grade plane; or
   2.2. The structure is constructed using a reinforced masonry structural system or reinforced concrete structural system; the design spectral response acceleration at short periods, S_{DS}, as determined in Section 1615.1, does not exceed 0.5g, and the height of the structure does not exceed 25 feet (7620 mm) above grade plane; or
   2.3. The structure is a detached one- or two-family dwelling not exceeding two stories in height; and
      2.3.1. The structure is classified as Seismic Use Group I, as determined in Section 1616.2; and
      2.3.2. The structure does not have any of the following plan or vertical irregularities as defined in Section 1616.5:
         a. Torsional irregularity.
         b. Nonparallel systems.
         c. Stiffness irregularity–extreme soft story and soft story.
         d. Discontinuity in capacity—weak story.

❖ This section provides minimum requirements for quality assurance for seismic-force-resisting systems and designated seismic systems. These requirements supplement the testing and inspection requirements contained in the referenced standards given in other sections of the code. The seismic provisions of the code rely heavily on the concept of quality control for good construction.

The exceptions to the preparation of a quality assurance plan are intended for conventional light-frame wood construction and structures constructed of light wood framing and light gauge cold-formed steel framing with a height no greater than 35 feet (10 668 mm) above grade plane that are located in areas of low seismic risk (S_{DS} does not exceed 0.50g) and that satisfy all of the criteria indicated, or structures constructed of reinforced masonry not more than 25 feet (7620 mm) above grade plane that are located in areas of low seismic risk (S_{DS} does not exceed 0.50g), and that satisfy all of the criteria indicated.

Exception 2.3 applies to detached one- or two-family dwellings not exceeding two stories in height that are included in Seismic Use Group I. The exception is also limited to those structures that do not have any of the following irregularities: torsional irregularity; extreme torsional irregularity; nonparallel systems; stiffness irregularity (soft story); stiffness irregularity (extreme soft story) or discontinuity in capacity (weak story). Any structure that does not satisfy all of the criteria included in the exception or is otherwise exempted by the code is required to have a quality assurance plan prepared by a registered design professional. It is important to emphasize that this exception is for the preparation of a quality assurance plan, not for the design of the structure in accordance with the requirements of the code.

1705.2 Quality assurance plan preparation. The design of each designated seismic system shall include a quality assurance plan prepared by a registered design professional. The quality assurance plan shall identify the following:

1. The designated seismic systems and seismic-force-resisting systems that are subject to quality assurance in accordance with Section 1705.1.
2. The special inspections and testing to be provided as required by Sections 1704 and 1708 and other applicable sections of this code, including the applicable reference standards referred to by this code.
3. The type and frequency of testing required.
4. The type and frequency of special inspections required.
5. The required frequency and distribution of testing and special inspection reports.
6. The structural observations to be performed.
7. The required frequency and distribution of structural observation reports.

❖ The quality assurance plan must be prepared by the registered design professional responsible for the design of each designated seismic system that is subject to quality assurance, whether it be architectural, electrical, mechanical or structural in nature. The quality assurance plan may be a very simple listing of those elements of each system that have been designated as being important enough to receive special inspections or testing. The extent and duration of the inspections must be set forth in the quality assurance plan, as well as the specific tests and the frequency of testing that is required.

1705.3 Contractor responsibility. Each contractor responsible for the construction of a seismic-force-resisting system, designated seismic system, or component listed in the quality assur-

ance plan shall submit a written contractor's statement of responsibility to the building official and to the owner prior to the commencement of work on the system or component. The contractor's statement of responsibility shall contain the following:

1. Acknowledgment of awareness of the special requirements contained in the quality assurance plan.
2. Acknowledgment that control will be exercised to obtain conformance with the construction documents approved by the building official.
3. Procedures for exercising control within the contractor's organization, the method and frequency of reporting, and the distribution of the reports.
4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

❖ The authority having jurisdiction must approve the quality assurance plan and obtain from each contractor a written statement that he or she understands the requirements of the quality assurance plan and will exercise the necessary control to obtain conformance. The exact methods of control are the responsibility of the individual contractors, subject to approval by the authority having jurisdiction. However, special inspections of the work are required in specific situations to provide the authority having jurisdiction reasonable assurance that there is compliance with the approved construction documents.

The extent of the qualifications of contractors and subcontractors can vary considerably, which is why the extent of quality control can also vary considerably. The quality assurance plan, therefore, is an opportunity to identify those areas of special concern that must be addressed during the construction process. Those areas include but are not limited to: types of testing; frequency of testing; types of inspections; frequency of inspections and the extent of the structural observations to be performed.

SECTION 1706
QUALITY ASSURANCE FOR WIND REQUIREMENTS

1706.1 Scope. A quality assurance plan shall be provided in accordance with Section 1706.1.1.

❖ This section provides minimum requirements for quality assurance of windforce-resisting systems and designated wind systems. These requirements supplement the testing and inspection requirements contained in the referenced standards given in other sections of the code. The wind provisions of the code are written to rely heavily on the concept of quality controls for good construction.

1706.1.1 Where required. A quality assurance plan for wind requirements shall be provided for all structures constructed in the following areas:

1. In wind exposure Categories A and B, where the 3-second-gust basic wind speed is 120 miles per hour (mph) (52.8 m/sec) or greater.
2. In wind exposure Categories C and D, where the 3-second-gust basic wind speed is 110 mph (49 m/sec) or greater.

Exception: A quality assurance plan is not required for structures designed and constructed in accordance with the *International Residential Code* or the conventional construction provisions of Section 2308 of this code, provided that all of the applicable items listed in Section 1706.1.2 are inspected during construction by a qualified person approved by the building official.

❖ A quality assurance plan for wind requirements is only required for high-wind areas. The exception to the preparation of a quality assurance plan is intended for conventional light-frame wood structures designed and constructed in accordance with the *International Residential Code*® (IRC®), provided that all of the applicable items listed in Section 1706.1.2 are inspected.

1706.1.2 Detailed requirements. Where required by Section 1706.1.1, a quality assurance plan shall be provided for the following:

1. Roof cladding and roof framing connections.
2. Wall connections to roof and floor diaphragms and framing.
3. Roof and floor diaphragm systems, including collectors, drag struts, and boundary elements.
4. Vertical windforce-resisting systems, including braced frames, moment frames and shear walls.
5. Windforce-resisting system connections to the foundation.
6. Fabrication and installation of components and assemblies required to meet the impact resistance requirements of Section 1609.1.4.

Exception: Fabrication of manufactured components and assemblies that have a label indicating compliance with the wind-load and impact-resistance requirements of this code.

❖ This section designates the wind systems that the quality assurance plan must address when one is required. Note that these items will require inspection during construction for those structures listed in the exception to Section 1706.1.1, even though a quality assurance plan is not required. The exception exempts manufactured components and assemblies that are labeled as complying with the required wind load and impact resistance.

1706.2 Quality assurance plan preparation. The design of each main windforce-resisting system and each wind-resisting component shall include a quality assurance plan prepared by a registered design professional.

Exception: For construction that is not required to be designed by a registered design professional, the quality assurance plan may be prepared by a qualified person approved by the building official.

The quality assurance plan shall identify the following:

1. The main windforce-resisting systems and wind-resisting components that are subject to quality assurance in accordance with Section 1706.1.
2. The special inspections and testing to be provided as required by Section 1704 and other applicable sections of this code, including the applicable referenced standards referred to by this code.
3. The type and frequency of testing required.
4. The type and frequency of special inspections required.
5. The required frequency and distribution of testing and special inspection reports.
6. The structural observations to be performed.
7. The required frequency and distribution of structural observation reports.

❖ The quality assurance plan must be prepared by a registered design professional. It may be a very simple listing of elements of each system designated as important enough to receive special inspections or testing. The extent and duration of the inspections must be set forth in the quality assurance plan, as well as the specific tests and frequency of testing required. The exception allows the quality assurance plan to be prepared by a qualified person other than a registered design professional if the construction is not required to be designed by a registered design professional.

1706.3 Contractor responsibility. Each contractor responsible for the construction of a main windforce-resisting system or a wind-resisting component listed in the quality assurance plan shall submit a written contractor's statement of responsibility to the building official and to the owner prior to the commencement of work on the system or component. The contractor's statement of responsibility shall contain the following:

1. Acknowledgment of awareness of the special requirements contained in the quality assurance plan;
2. Acknowledgment that control will be exercised to obtain conformance with the construction documents approved by the building official;
3. Procedures for exercising control within the contractor's organization, the method and frequency of reporting, and the distribution of the reports; and
4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

❖ The authority having jurisdiction must approve the quality assurance plan and must obtain from each contractor a written statement that he or she understands the requirements of the quality assurance plan and will exercise the necessary control to obtain conformance. The exact methods of control are the responsibility of individual contractors, subject to approval by the authority having jurisdiction. However, special inspections of the work are required in specific situations to provide the authority having jurisdiction reasonable assurance that there is compliance with the approved construction documents.

The extent of the qualifications of the contractor and subcontractors can vary considerably. The quality assurance plan, therefore, is an opportunity to identify those areas of special concern that must be addressed during the construction process, including, but not limited to, types of testing, frequency of testing, types of inspections, frequency of inspections and the extent of the structural observations to be performed.

SECTION 1707
SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE

1707.1 Special inspections for seismic resistance. Special inspection as specified in this section is required for the following, where required in Section 1704.1. Special inspections itemized in Sections 1707.2 through 1707.8 are required for the following:

1. The seismic-force-resisting systems in structures assigned to Seismic Design Category C, D, E or F, as determined in Section 1616.
2. Designated seismic systems in structures assigned to Seismic Design Category D, E or F.
3. Architectural, mechanical and electrical components in structures assigned to Seismic Design Category C, D, E or F that are required in Sections 1707.6 and 1707.7.

❖ The requirements in this section supplement the inspection requirements contained in the referenced standards in other sections of the code. The seismic provisions of the code are written to rely heavily on the concept of special inspections for good construction.

1707.2 Structural steel. Continuous special inspection for structural welding in accordance with AISC 341.

Exceptions:

1. Single-pass fillet welds not exceeding $^5/_{16}$ inch (7.9 mm) in size.
2. Floor and roof deck welding.

❖ Continuous special inspection is required for all structural steel welding except single-pass fillet welds not exceeding $^5/_{16}$ inch (7.9 mm) and floor and roof deck welding.

1707.3 Structural wood. Continuous special inspection during field gluing operations of elements of the seismic-force-resisting system. Periodic special inspections for nailing, bolting, anchoring and other fastening of components within the

seismic-force-resisting system, including drag struts, braces and hold-downs.

Exception: Fastening of wood sheathing used for wood shear walls, shear panels and diaphragms where the fastener spacing is more than 4 inches (102 mm) on center (o.c.).

❖ Continuous special inspection of field gluing operations of structural wood is required, while only periodic special inspection of fastenings of components within the seismic-force-resisting system is required. The exception waives periodic special inspection of wood sheathing fastening in shear walls and diaphragms that resist relatively low shear forces. Rather than being based on the component's design shear, fastener spacing is considered a more practical reason for special inspection. All things being equal, as the fastener spacing decreases, not only is the component's design load higher, but also the potential for splitting framing members increases. The latter concern is mainly associated with nailing.

1707.4 Cold-formed steel framing. Periodic special inspections during welding operations of elements of the seismic-force-resisting system. Periodic special inspections for screw attachment, bolting, anchoring and other fastening of components within the seismic-force-resisting system, including struts, braces, and hold-downs.

❖ Periodic special inspection is required for cold-formed steel framing and its fastening.

1707.5 Storage racks and access floors. Periodic special inspection during the anchorage of access floors and storage racks 8 feet (2438 mm) or greater in height in structures assigned to Seismic Design Category D, E or F.

❖ The anchorage of storage racks and access floors in structures assigned to Seismic Design Category D, E or F requires periodic special inspection.

1707.6 Architectural components. Periodic special inspection during the erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior veneer in structures assigned to Seismic Design Category D, E or F.

Exceptions:

1. Special inspection is not required for architectural components in structures 30 feet (9144 mm) or less in height.
2. Special inspection is not required for cladding and veneer weighing 5 pounds psf (24.5 N/m^2) or less.
3. Special inspection is not required for interior nonbearing walls weighing 15 psf (73.5 N/m^2) or less.

❖ It is anticipated that the minimum requirements for architectural components will be complied with when the special inspector is satisfied that the method of anchoring or fastening and the number, spacing and types of fasteners actually used conform with the approved construction documents for the component installed. It is noted that such special inspection requirements are only for those components in Seismic Design Category D, E or F.

1707.7 Mechanical and electrical components. Periodic special inspection during the anchorage of electrical equipment for emergency or standby power systems in structures assigned to Seismic Design Category C, D, E or F. Periodic special inspection during the installation of anchorage of other electrical equipment in structures assigned to Seismic Design Category E or F. Periodic special inspection during installation of piping systems intended to carry flammable, combustible, or highly toxic contents and their associated mechanical units in structures assigned to Seismic Design Category C, D, E or F. Periodic special inspection during the installation of HVAC ductwork that will contain hazardous materials in structures assigned to Seismic Design Category C, D, E or F.

❖ It is anticipated that the minimum requirements for mechanical and electrical components will be complied with when the special inspector is satisfied that the method of anchoring or fastening and the number, spacing and types of fasteners actually used conform with the approved construction documents for the components installed. It is noted that such special inspection requirements are for selected electrical, lighting, piping and ductwork components in Seismic Design Category C, D, E or F.

1707.7.1 Component inspection. Special inspection is required for the installation of the following components where the component has a Component Importance Factor of 1.0 or 1.5 in accordance with Section 9.6.1.5 of ASCE 7. Evidence of the quality control program shall be permanently identified on each piece of equipment by a label.

1. Equipment using combustible energy sources.
2. Electrical motors, transformers, switchgear unit substations and motor control centers.
3. Reciprocating and rotating-type machinery.
4. Piping distribution systems 3 inches (76 mm) and larger.
5. Tanks, heat exchangers and pressure vessels.

❖ This section delineates the mechanical and electrical components that are required to have special inspection.

1707.7.2 Component and attachment testing. The component manufacturer shall test or analyze the component and the component mounting system or anchorage for the design forces in Chapter 16 for those components having a Component Importance Factor of 1.0 or 1.5 in accordance with Chapter 16. The manufacturer shall submit a certificate of compliance for review and acceptance by the registered design professional responsible for the design, and for approval by the building official. The basis of certification shall be by test on a shaking table, by three-dimensional shock tests, by an analytical method using dynamic characteristics and forces from Chapter 16 or by more rigorous analysis. The special inspector shall inspect the com-

ponent and verify that the label, anchorage or mounting conforms to the certificate of compliance.

❖ This section requires that components having a Component Importance Factor of 1.0 or 1.5 must demonstrate seismic performance by testing or analytical methods. A certificate of compliance for review and acceptance is also required. The registered design professional responsible for the design then must review and accept the certificate of compliance, and the building official must approve it. Verification is required by the special inspector that the component label, anchorage or mounting conforms to the certificate of compliance.

1707.7.3 Component manufacturer certification. Each manufacturer of equipment to be placed in a building assigned to Seismic Design Categories E and F, in accordance with Chapter 16, where the equipment has a Component Importance Factor of 1.0 or 1.5 in accordance with Chapter 16, shall maintain an approved quality control program. Evidence of the quality control program shall be permanently identified on each piece of equipment by a label.

❖ The manufacturer of equipment that has a Component Importance Factor of 1.0 or 1.5 and is to be used in Seismic Design Categories E and F must maintain an approved quality control program. Each piece of equipment must be labeled as permanent evidence of the quality control program.

1707.8 Seismic isolation system. Provide periodic special inspection during the fabrication and installation of isolator units and energy dissipation devices if used as part of the seismic isolation system.

❖ Seismic isolation units and energy dissipation devices must receive periodic special inspection during fabrication and installation.

SECTION 1708
STRUCTURAL TESTING FOR SEISMIC RESISTANCE

1708.1 Masonry. Testing and verification of masonry materials and assemblies prior to construction shall comply with the requirements of this section, depending on the classification of building or structure or nature of occupancy, as defined in this code (see Table 1604.5 or Section 1616.2).

❖ This section establishes the level of quality assurance required for masonry construction. This is determined by the design method (empirical versus engineered) and whether or not a structure is classified as an essential facility. These requirements are summarized in Table 1708.1. An essential facility would be an Occupancy Category IV in Table 1604.5 and/or Seismic Use Group III in accordance with Section 1616.2.3. The quality assurance levels identified as Level 1 and Level 2 coincide with the level of special inspection required by Section 1704.5.

TABLE 1708.1
QUALITY ASSURANCE OF MASONRY CONSTRUCTION

	TYPE OF FACILITY			
	Nonessential		Essential	
Design method	Empirical	Engineered	Empirical	Engineered
Quality assurance	a	Level 1	Level 1	Level 2

a. Certificate of compliance (see Section 1708.1.1).

1708.1.1 Empirically designed masonry and glass unit masonry in nonessential facilities. For masonry designed by Section 2109 or 2110, or by Chapter 5 or 7 of ACI 530/ASCE 5/TMS 402, in nonessential facilities (see Table 1604.5 or Section 1616.2), certificates of compliance used in masonry construction shall be verified prior to construction.

❖ The minimum level of testing and verification required for empirically designed masonry and glass unit masonry in nonessential facilities is a certificate of compliance indicating that the masonry materials used comply with the code and contract documents.

1708.1.2 Empirically designed masonry and glass unit masonry in essential facilities. The minimum testing and verification prior to construction for masonry designed by Section 2109 or 2110, or by Chapter 5 or 7 of ACI 530/ASCE 5/TMS 402, in essential facilities (see Table 1604.5 or Section 1616.2) shall comply with the requirements of Table 1708.1.2, Level 1 Quality Assurance.

❖ The minimum level of testing and verification required for empirically designed masonry and glass unit masonry in essential facilities is a certificate of compliance indicating that the masonry materials used comply with the code and contract documents plus verification of f'_m prior to construction (see Table 1708.1.2, Level 1 Quality Assurance).

TABLE 1708.1.2
LEVEL 1 QUALITY ASSURANCE

MINIMUM TESTS AND SUBMITTALS
Certificates of compliance used in masonry construction.
Verification of f'_m prior to construction, except where specifically exempted by this code.

❖ See the commentary to Section 1708.1.4 for discussion.

1708.1.3 Engineered masonry in nonessential facilities. The minimum testing and verification prior to construction for masonry designed by Section 2107 or 2108, or by chapters other than Chapter 5, 6 or 7 of ACI 530/ASCE 5/TMS 402, in nonessential facilities (see Table 1604.5 or Section 1616.2) shall comply with Table 1708.1.2.

❖ Engineered masonry in nonessential facilities requires the same testing and verification as empirically de-

signed in essential facilities (see Table 1708.1.2, Level 1 Quality Assurance).

1708.1.4 Engineered masonry in essential facilities. The minimum testing and verification prior to construction for masonry designed by Section 2107 or 2108, or by chapters other than Chapter 5, 6 or 7 of ACI 530/ASCE 5/TMS 402, in essential facilities (see Table 1604.5 or Section 1616.2) shall comply with Table 1708.1.4, Level 2 Quality Assurance.

❖ Engineered masonry in essential facilities requires testing and verification prior to construction. The minimum tests and submittals are listed in Table 1708.1.4. The requirements are the same as for engineered masonry in nonessential facilities, with the added requirements that f'_m must be verified every 5,000 square feet (465 m^2) during construction and the proportions of materials in mortar and grout must be verified as delivered to the site (see Table 1708.1.4, Level 2 Quality Assurance).

TABLE 1708.1.4
LEVEL 2 QUALITY ASSURANCE

MINIMUM TESTS AND SUBMITTALS
Certificates of compliance used in masonry construction.
Verification of f'_m prior to construction and every 5000 square feet during construction.
Verification of proportions of materials in mortar and grout as delivered to the site.

For SI: 1 square foot = 0.0929 m^2.

❖ See the commentary to Section 1708.1.4 for discussion.

1708.2 Testing for seismic resistance. The tests specified in Sections 1708.3 through 1708.6 are required for the following:

1. The seismic-force-resisting systems in structures assigned to Seismic Design Category C, D, E or F, as determined in Section 1616.
2. Designated seismic systems in structures assigned to Seismic Design Category D, E or F.
3. Architectural, mechanical and electrical components in structures assigned to Seismic Design Category C, D, E or F that are required in Section 1708.5.

❖ This section specifies when material seismic resistance tests for seismic-force-resisting systems and designated seismic systems are required. These requirements supplement the test requirements contained in the referenced standards given in other sections of the code. The seismic provisions of the code are written to rely heavily on the concept of material tests such that good quality material is used for seismic-resistant construction.

1708.3 Reinforcing and prestressing steel. Certified mill test reports shall be provided for each shipment of reinforcing steel used to resist flexural, shear and axial forces in reinforced concrete intermediate frames, special moment frames and boundary elements of special reinforced concrete or reinforced masonry shear walls. Where ASTM A 615 reinforcing steel is used to resist earthquake-induced flexural and axial forces in special moment frames and in wall boundary elements of shear walls in structures assigned to Seismic Design Category D, E or F, as determined in Section 1616, the testing requirements of ACI 318 shall be met. Where ASTM A 615 reinforcing steel is to be welded, chemical tests shall be performed to determine weldability in accordance with Section 1903.5.2.

❖ Certified material test reports are required for rebar. When ASTM A 615 is used in special moment frames and shear walls in structures in Seismic Design Category D, E or F, the testing requirements of ACI 318 must be used. Where ASTM A 615 rebar is to be welded, a chemical analysis must be provided to determine weldability of the steel in accordance with AWS D1.4.

1708.4 Structural steel. The testing contained in the quality assurance plan shall be as required by AISC 341 and the additional requirements herein. The acceptance criteria for nondestructive testing shall be as required in AWS D1.1 as specified by the registered design professional.

Base metal thicker than 1.5 inches (38 mm), where subject to through-thickness weld shrinkage strains, shall be ultrasonically tested for discontinuities behind and adjacent to such welds after joint completion. Any material discontinuities shall be accepted or rejected on the basis of ASTM A 435 or ASTM A 898 (Level 1 Criteria) and criteria as established by the registered design professional(s) in responsible charge and the construction documents.

❖ Structural steel must be tested as required by AISC 341. Any nondestructive testing must use the acceptance criteria in AWS D1.1 and as specified by the registered design professional. Base metal thicker than 1.5 inches (38 mm) is subject to laminations and discontinuities during the steel-making process. Any base metal thicker than 1.5 inches (38 mm) that will be subjected to through-thickness weld shrinkage strains must be ultrasonically tested after welding is completed. The acceptance criteria for ultrasonic testing are required to be on the basis of ASTM A 435 or A 898 (Level 1 criteria) and as established by the registered design professional.

1708.5 Mechanical and electrical equipment. Each manufacturer of designated seismic system components shall test or analyze the component and its mounting system or anchorage and shall submit a certificate of compliance for review and acceptance by the registered design professional in responsible charge of the design of the designated seismic system and for approval by the building official. The evidence of compliance shall be by actual test on a shake table, by three-dimensional shock tests, by an analytical method using dynamic characteristics and forces, by the use of experience data (i.e., historical data demonstrating acceptable seismic performance), or by more rigorous analysis providing for equivalent safety. The special inspector shall examine the designated seismic system and shall determine whether the anchorages and label conform with the evidence of compliance.

❖ Mechanical and electrical components having a Component Importance Factor of 1.0 or 1.5 must demonstrate seismic performance by testing or analytical

methods. A certificate of compliance for review and acceptance is also required. The registered design professional responsible must then review and accept the certificate of compliance, and the building official must approve it. Verification is required by the special inspector that the component label, anchorage or mounting conforms to the certificate of compliance.

1708.6 Seismically isolated structures. For required system tests, see Section 9.13.9 of ASCE 7.

❖ The referenced section of ASCE 7 contains detailed provisions for isolation system testing. This testing provides effective stiffness and effective damping values to be used in the design of a seismically isolated structure. A minimum of two full-size specimens must be tested for each proposed type and size of isolator unit. These prototypes are not to be used in the construction, unless approved by both the registered design professional and the building official.

SECTION 1709
STRUCTURAL OBSERVATIONS

1709.1 Structural observations. Structural observations shall be provided for those structures included in Seismic Design Category D, E or F, as determined in Section 1616, where one or more of the following conditions exist:

1. The structure is included in Seismic Use Group II or III.
2. The height of the structure is greater than 75 feet (22 860 mm) above the base.
3. The structure is in Seismic Design Category E and Seismic Use Group I and greater than two stories in height.
4. When so designated by the registered design professional in responsible charge of the design.
5. When such observation is specifically required by the building official.

Structural observations shall also be provided for those structures sited where the basic wind speed exceeds 110 miles per hour (3 second gust) determined from Figure 1609, where one or more of the following conditions exist:

1. The structure is included in Category III or IV according to Table 1604.5.
2. The height of the structure is greater than 75 feet (22 860 mm).
3. When so designated by the registered design professional in responsible charge of the design,
4. When such observation is specifically required by the building official.

The owner shall employ a registered design professional to perform structural observation as defined in Section 1702.

Deficiencies shall be reported in writing to the owner and the building official. At the conclusion of the work included in the permit, the structural observer shall submit to the building official a written statement that the site visits have been made and identify any reported deficiencies which, to the best of the structural observer's knowledge, have not been resolved.

❖ This section requires that a registered engineer or architect be employed by the owner to provide on-site visits to observe compliance with the structural drawings. Structural observations are required under certain conditions in high-seismic and high-wind locations (see Section 1702 for the definition of "Structural observation").

The intent of requiring structural observations by a registered design professional for these structures is to verify that the seismic-force-resisting systems, the designated seismic systems and the windforce-resisting systems are constructed in general conformance with the construction documents.

SECTION 1710
DESIGN STRENGTHS OF MATERIALS

1710.1 Conformance to standards. The design strengths and permissible stresses of any structural material that are identified by a manufacturer's designation as to manufacture and grade by mill tests, or the strength and stress grade is otherwise confirmed to the satisfaction of the building official, shall conform to the specifications and methods of design of accepted engineering practice or the approved rules in the absence of applicable standards.

❖ Structural materials must conform to applicable design standards, approved rules and accepted methods of engineering practice. Conformance to these provisions and to the manufacturer's designations provides the building official with the information needed to verify that the materials will perform their intended function satisfactorily.

1710.2 New materials. For materials that are not specifically provided for in this code, the design strengths and permissible stresses shall be established by tests as provided for in Section 1711.

❖ Materials that are not explicitly covered by the code are allowed when subjected to the appropriate testing demonstrating adequate performance (see Section 1701.2).

SECTION 1711
ALTERNATIVE TEST PROCEDURE

1711.1 General. In the absence of approved rules or other approved standards, the building official shall make, or cause to be made, the necessary tests and investigations; or the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials

or assemblies as provided for in Section 104.11. The cost of all tests and other investigations required under the provisions of this code shall be borne by the permit applicant.

❖ Test reports from approved agencies may be used as a basis for approval of materials that are not within the purview of any approved rules (i.e., "new materials" as mentioned in Section 1701.2). This section directly references Section 104.11. It is within the power of the building official to accept reports from an approved agency. In determining the approval, the building official should check that the agency is an independent third-party agency with no financial or fiduciary affiliations with the applicant or material supplier. The capability and competency of the agency must also be examined. It should be noted that this section assigns responsibility for costs of the testing to the applicant.

SECTION 1712
TEST SAFE LOAD

1712.1 Where required. Where proposed construction is not capable of being designed by approved engineering analysis, or where proposed construction design method does not comply with the applicable material design standard, the system of construction or the structural unit and the connections shall be subjected to the tests prescribed in Section 1714. The building official shall accept certified reports of such tests conducted by an approved testing agency, provided that such tests meet the requirements of this code and approved procedures.

❖ Testing to determine safe load is required when a structural component cannot be designed in accordance with approved engineering practices or where the construction design method does not fully comply with the respective material design standard listed in Chapter 35. If either of these situations exist, the structural components are required to be subjected to the prescriptive tests listed in Section 1714, which address loading and deflection criteria.

An example of a structural component that cannot be designed by approved engineering practice is a composite concrete and steel slab in which the shear connector is some type of new configuration called a "widget." The horizontal shear that can be developed is unknown, therefore, a complete analysis cannot be performed. This section also restates the building official's option of accepting data from an approved testing agency, as previously stated in Section 1703.4.

SECTION 1713
IN-SITU LOAD TESTS

1713.1 General. Whenever there is a reasonable doubt as to the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected loads, an engineering assessment shall be required. The engineering assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standard. If the structural assessment determines that the load-bearing capacity is less than that required by the code, load tests shall be conducted in accordance with Section 1713.2. If the building, structure or portion thereof is found to have inadequate stability or load-bearing capacity for the expected loads, modifications to ensure structural adequacy or the removal of the inadequate construction shall be required.

❖ The intent of this section is to utilize an engineering analysis to verify the adequacy of the structure, if possible. The load test requirement should only be done if an engineering analysis does not verify structural adequacy. Load tests are last resort options, and the building official should document his or her reasons for any load testing requirement.

An example of the structural analysis executed would be an analysis by a third-party engineering firm acceptable to both the building official and the owner. The structural integrity may be questioned for items such as visible signs of excessive settlement or lateral deflection, such as cracks in concrete foundation walls or excessive vibration when the assembly is loaded.

A load test procedure must simulate the actual load conditions to which the structure is subjected during normal use (see Section 1713.3 for details).

1713.2 Test standards. Structural components and assemblies shall be tested in accordance with the appropriate material standards listed in Chapter 35. In the absence of a standard that contains an applicable load test procedure, the test procedure shall be developed by a registered design professional and approved. The test procedure shall simulate loads and conditions of application that the completed structure or portion thereof will be subjected to in normal use.

❖ When load test procedures for materials are given by the applicable referenced material standard, the test procedure outlined in that specific standard must be adhered to without variation. If a referenced standard lacks a load test procedure or a material or assembly does not have a specific referenced standard, then such a test must be developed by a registered design professional and approved by the building official. The test procedure must be representative of and simulate the actual loading conditions that the completed structure or portion thereof will be subjected to during normal use.

1713.3 In-situ load tests. In-situ load tests shall be conducted in accordance with Section 1713.3.1 or 1713.3.2 and shall be supervised by a registered design professional. The test shall simulate the applicable loading conditions specified in Chapter 16 as necessary to address the concerns regarding structural stability of the building, structure or portion thereof.

❖ The criteria for in-situ load tests are set forth for two categories: procedures specified, which are regulated by Section 1713.3.1, and procedures not specified, which are regulated by Section 1713.3.2. This section further requires that the test be performed under the supervision of a registered design professional and that it simu-

late the actual loads and conditions of the completed structure or portion thereof.

1713.3.1 Load test procedure specified. Where a standard listed in Chapter 35 contains an applicable load test procedure and acceptance criteria, the test procedure and acceptance criteria in the standard shall apply. In the absence of specific load factors or acceptance criteria, the load factors and acceptance criteria in Section 1713.3.2 shall apply.

❖ The load test must be in accordance with the applicable referenced standard. Section 1713.3.2 must only be utilized in the absence of either a specific standard or specific load factors and acceptance criteria from applicable referenced standards.

1713.3.2 Load test procedure not specified. In the absence of applicable load test procedures contained within a standard referenced by this code or acceptance criteria for a specific material or method of construction, such existing structure shall be subjected to a test procedure developed by a registered design professional that simulates applicable loading and deformation conditions. For components that are not a part of the seismic load-resisting system, the test load shall be equal to two times the unfactored design loads. The test load shall be left in place for a period of 24 hours. The structure shall be considered to have successfully met the test requirements where the following criteria are satisfied:

1. Under the design load, the deflection shall not exceed the limitations specified in Section 1604.3.
2. Within 24 hours after removal of the test load, the structure shall have recovered not less than 75 percent of the maximum deflection.
3. During and immediately after the test, the structure shall not show evidence of failure.

❖ If the applicable standards do not specify load factor or testing criteria acceptance methods, then the testing criteria listed in this section must be followed. Note that the design load includes design live load and all dead loads that are not yet in place, such as the dead load from tenant walls in a speculative office building.

SECTION 1714
PRECONSTRUCTION LOAD TESTS

1714.1 General. In evaluating the physical properties of materials and methods of construction that are not capable of being designed by approved engineering analysis or that do not comply with applicable material design standards listed in Chapter 35, the structural adequacy shall be predetermined based on the load test criteria established in this section.

❖ This section establishes requirements for load testing structural assemblies that are either incapable of being designed or those that, for one reason or another, do not comply with the applicable material design standards. This section does not govern the load testing of existing buildings, which is governed by Section 1713.

The different categories of preconstruction load tests are addressed herein. Specified load test procedures are regulated by Section 1714.2. Load test procedures that are not specified are regulated by Section 1714.3. Wall and partition assemblies are regulated by Section 1714.4. Exterior window and door assemblies are regulated by Section 1714.5, and test specimens are regulated by Section 1714.6.

1714.2 Load test procedures specified. Where specific load test procedures, load factors and acceptance criteria are included in the applicable design standards listed in Chapter 35, such test procedures, load factors and acceptance criteria shall apply. In the absence of specific test procedures, load factors or acceptance criteria, the corresponding provisions in Section 1714.3 shall apply.

❖ This section has priority over Section 1714.3, provided that load factors and acceptance criteria are established in the applicable design standards.

1714.3 Load test procedures not specified. Where load test procedures are not specified in the applicable design standards listed in Chapter 35, the load-bearing and deformation capacity of structural components and assemblies shall be determined on the basis of a test procedure developed by a registered design professional that simulates applicable loading and deformation conditions. For components and assemblies that are not a part of the seismic load-resisting system, the test shall be as specified in Section 1714.3.1. Load tests shall simulate the applicable loading conditions specified in Chapter 16.

❖ In the absence of load factors and acceptance criteria in the applicable design standards and in accordance with Section 1714.2, this section is to be used by the building official to determine if conformance to the applicable code requirements has been achieved. Additionally, this section provides the design professional and the building official with specific loading and pass/fail criteria.

1714.3.1 Test procedure. The test assembly shall be subjected to an increasing superimposed load equal to not less than two times the superimposed design load. The test load shall be left in place for a period of 24 hours. The tested assembly shall be considered to have successfully met the test requirements if the assembly recovers not less than 75 percent of the maximum deflection within 24 hours after the removal of the test load. The test assembly shall then be reloaded and subjected to an increasing superimposed load until either structural failure occurs or the superimposed load is equal to two and one-half times the load at which the deflection limitations specified in Section 1714.3.2 were reached, or the load is equal to two and one-half times the superimposed design load. In the case of structural components and assemblies for which deflection limitations are not specified in Section 1714.3.2, the test specimen shall be subjected to an increasing superimposed load until structural failure occurs or the load is equal to two and one-half times the desired superimposed design load. The allowable superimposed design load shall be taken as the lesser of:

1. The load at the deflection limitation given in Section 1714.3.2.

2. The failure load divided by 2.5.
3. The maximum load applied divided by 2.5.

❖ Load test criteria relating to superimposed design loads are established herein. These requirements are a compilation of commonly accepted engineering practices to test adequately against structural failure.

In the case of structural components and assemblies for which maximum deflection limitations are not addressed in Section 1714.3.2, the test assemblies must be subjected to increasing superimposed loads until failure occurs or the load is equal to two and one-half times the superimposed design load, whichever occurs first.

1714.3.2 Deflection. The deflection of structural members under the design load shall not exceed the limitations in Section 1604.3.

❖ Acceptance criteria for deflection of structural systems when subjected to the allowable design load are used to demonstrate adequate structural performance and are addressed in Section 1604.3.

1714.4 Wall and partition assemblies. Load-bearing wall and partition assemblies shall sustain the test load both with and without window framing. The test load shall include all design load components. Wall and partition assemblies shall be tested both with and without door and window framing.

❖ Load-bearing wall and partition assemblies must sustain loads with and without window framing. It is not appropriate to assume that a wall will sustain loads better if window framing is involved in the test. Each individual design must be evaluated separately based on the construction of that assembly. All design loads, such as vertical and lateral forces, must be included in the test.

1714.5 Exterior window and door assemblies. The design pressure rating of exterior windows and doors in buildings shall be determined in accordance with Section 1714.5.1 or 1714.5.2.

Exception: Structural wind load design pressures for window units smaller than the size tested in accordance with Section 1714.5.1 or 1714.5.2 shall be permitted to be higher than the design value of the tested unit provided such higher pressures are determined by accepted engineering analysis. All components of the small unit shall be the same as the tested unit. Where such calculated design pressures are used, they shall be validated by an additional test of the window unit having the highest allowable design pressure.

❖ This section allows two methods of load test for exterior window and door assemblies. The first method, provided for in Section 1714.5.1, allows products to be tested and labeled as conforming to AAMA/NWWDA/101/I.S.2. The second method allows products to be tested in accordance with ASTM E 330 and the glazing must comply with Section 2403. The exception allows window units smaller than the size tested to have higher design pressures, provided the higher pressures are determined by accepted engineering analysis, all components of the smaller unit are the same as the tested unit and an additional test of the smaller unit having the highest calculated design pressure is performed in accordance with Section 1714.5.1 or 1714.5.2.

1714.5.1 Aluminum, vinyl and wood exterior windows and glass doors. Aluminum, vinyl and wood exterior windows and glass doors shall be labeled as conforming to AAMA/NWWDA 101/I.S.2 or 101/I.S.2/NAFS. The label shall state the name of the manufacturer, the approved labeling agency and the product designation as specified in AAMA/NWWDA 101/I.S.2 or 101/I.S.2/NAFS. Products tested and labeled as conforming to AAMA/NWWDA 101/I.S.2 or 101/I.S.2/NAFS shall not be subject to the requirements of Sections 2403.2 and 2403.3.

❖ This section requires exterior windows and doors complying with AAMA/NWWDA/101/I.S.2 or 101/I.S.2/NAFS to be labeled as such. Products so tested and labeled must not be required to meet Sections 2403.2 and 2403.3. By requiring the product to be labeled, the building official does not have to interpret test results and determine load-carrying capacities, or accept the manufacturer's interpretation of tests.

1714.5.2 Exterior windows and door assemblies not provided for in Section 1714.5.1. Exterior window and door assemblies shall be tested in accordance with ASTM E 330. Exterior window and door assemblies containing glass shall comply with Section 2403. The design pressure for testing shall be calculated in accordance with Chapter 16. Each assembly shall be tested for 10 seconds at a load equal to 1.5 times the design pressure.

❖ This section allows an alternate to the provisions of Section 1714.5.1.

This procedure is to be used to verify the integrity of door and window assemblies as a whole, and its results do not supersede, but rather complement, the requirements of Chapter 24. Glass thickness must be determined in accordance with the provisions of Chapter 24. The assemblies must comply with Section 2403, and the design pressure for testing is determined from Chapter 16. Each assembly is required to be tested for 10 seconds at a load equal to 1.5 times the design pressure. When testing a product line that has a variety of sizes, the most critical size can usually be tested and the results used to qualify other similar products within its family. In general, the larger size and the most heavily loaded of each particular design, type, construction or configuration should be tested. The code does not specify how many specimens are to be tested. ASTM E 330 states that if only one sample is tested, it should be selected by the specifying authority.

1714.6 Test specimens. Test specimens and construction shall be representative of the materials, workmanship and details normally used in practice. The properties of the materials used to construct the test assembly shall be determined on the basis of tests on samples taken from the load assembly or on representa-

tive samples of the materials used to construct the load test assembly. Required tests shall be conducted or witnessed by an approved agency.

❖ The test specimen must resemble and simulate as much as possible the design being tested using materials and workmanship that could be expected in the actual construction or fabrication the test itself must be witnessed or conducted by an agency acceptable to and approved by the building official.

SECTION 1715
MATERIAL AND TEST STANDARDS

1715.1 Test standards for joist hangers and connectors.

❖ This section prescribes the test standard and criteria to be used for joist hangers and connectors. This criteria is meant to be used in establishing the load capacity of joist hangers and connectors used in wood construction for which there is no calculated procedure recognized by the code.

1715.1.1 Test standards for joist hangers. The vertical load-bearing capacity, torsional moment capacity, and deflection characteristics of joist hangers shall be determined in accordance with ASTM D 1761, using lumber having a specific gravity of 0.49 or greater, but not greater than 0.55, as determined in accordance with AFPA NDS for the joist and hangers.

❖ The specified ASTM standard test method provides a procedure for evaluating the vertical load-carrying capacity, torsional moment capacity and deflection characteristics of joist hangers and similar devices used to connect wood joists to headers of wood or other materials. The lumber used for the test specimen must have a specific gravity equal to or greater than 0.49, but not greater than 0.55.

1715.1.2 Vertical load capacity for joist hangers. The vertical load capacity for the joist hanger shall be determined by testing three joist hanger assemblies as specified in ASTM D 1761. If the ultimate vertical load for any one of the tests varies more than 20 percent from the average ultimate vertical load, at least three additional tests shall be conducted. The allowable vertical load for a normal duration of loading of the joist hanger shall be the lowest value determined from the following:

1. The lowest ultimate vertical load from any test divided by three (where three tests are conducted and each ultimate vertical load does not vary more than 20 percent from the average ultimate vertical load).
2. The average ultimate vertical load for all tests divided by six (where six or more tests are conducted).
3. The vertical load at which the vertical movement of the joist with respect to the header is 0.125 inch (3.2 mm) in any test.
4. The allowable design load for nails or other fasteners utilized to secure the joist hanger to the wood members.
5. The allowable design load for the wood members forming the connection.

❖ The method prescribed establishes the allowable load for normal duration, as defined by the American Forest & Paper Association (AF&PA) *National Design Specification (NDS) for Wood Construction*. Additionally, allowable stresses cannot exceed those allowed by the code. For example, published allowable loads cannot contain nail loads higher than those allowed by NDS, nor can tension in steel strapping exceed that allowed by the steel design standards noted in Chapter 22.

For loads of other than normal duration, the stresses or loads may be increased or must be decreased as noted by the appropriate design standard, but in no case can the load exceed that which will produce $^1/_8$-inch (3.2 mm) deflection.

EXAMPLE:

GIVEN: A manufacturer's test results for a particular joist hanger are as follows:

Test 1 Ultimate load = 1,000 lbs with the $^1/_8$-inch deflection occurring at 400 lbs.

Test 2 Ultimate load = 1,100 lbs with the $^1/_8$-inch deflection occurring at 350 lbs.

Test 3 Ultimate load = 900 lbs with the $^1/_8$-inch deflection occurring 375 lbs.

The manufacturer submitted structural calculations indicating that the allowable design load of the nails is 250 pounds (114 kg), and the allowable shear load in the wood joists framing to the hangers is 280 pounds (127 kg). Joist hanger geometry does not allow for any meaningful calculation of stresses in the steel sections of the hanger.

FIND: The allowable load for the joist hanger.

SOLUTION:

Average ultimate load = (1,000 + 1,100 + 900) ÷ 3.0 = 1,000 lbs

Since 20 percent of 1,000 is 200, the test scatter is within the allowable range of plus and minus 20 percent of the average ultimate load; therefore, three tests are sufficient to establish allowable load.

Thus, the allowable load is 250 pounds (114 kg) based on the lesser of:

Lowest ultimate load ÷ 3.0 = 300 lbs (137 kg)

$^1/_8$-inch deflection in any test = 350 lbs (159 kg)

Allowable nail load = 250 lbs (114 kg)

Allowable joist shear = 280 lbs (127 kg)

In this case, the allowable vertical load for a normal duration is limited by the calculated allowable design load of the fastener [250 lbs (113 kg)] in accordance with Item 4 of Section 1715.1.2. This value is permitted to be modified by a duration of loading factor; however, the modified value cannot exceed the lowest test value

as determined in accordance with Items 1, 2 and 3 of Section 1715.1.2.

1715.1.3 Torsional moment capacity for joist hangers. The torsional moment capacity for the joist hanger shall be determined by testing at least three joist hanger assemblies as specified in ASTM D 1761. The allowable torsional moment for normal duration of loading of the joist hanger shall be the average torsional moment at which the lateral movement of the top or bottom of the joist with respect to the original position of the joist is 0.125 inch (3.2 mm).

❖ The allowable torsional moment capacity for a joist hanger is determined by testing in accordance with ASTM D 1761 with the limitation that rotational deflection of the top or bottom of the joist with respect to the header must not exceed 0.125 inch (3.2 mm). This allowable torsional moment is not to be modified by duration of loading factors.

1715.1.4 Design value modifications for joist hangers. Allowable design values for joist hangers that are determined by Item 4 or 5 in Section 1715.1.2 shall be permitted to be modified by the appropriate duration of loading factors as specified in AFPA NDS but shall not exceed the direct loads as determined by Item 1, 2 or 3 in Section 1715.1.2. Allowable design values determined by Item 1, 2 or 3 in Sections 1715.1.2 and 2305.1 shall not be modified by duration of loading factors.

❖ The calculated allowable design values, as determined by Item 4 or 5 of Section 1715.1.2 and modified by duration of loading factors, must not exceed the lowest test value as determined by Item 1, 2 or 3 of Section 1715.1.2 or the value from Section 2305.1.

1715.2 Concrete and clay roof tiles.

❖ This section prescribes the test standards and criteria to be used to determine the overturning resistance and wind characteristics of concrete and clay roof tiles.

1715.2.1 Overturning resistance. Concrete and clay roof tiles shall be tested to determine their resistance to overturning due to wind in accordance with SBCCI SSTD 11 and Chapter 15.

❖ Section 1715.2.1 requires concrete and clay tiles to be tested to determine their overturning resistance in accordance with SBCCI SSTD 11. SSTD 11 prescribes methods for determining the allowable overturning moment for mechanically fastened, adhesive-set and mortar-set tiles. A test procedure is also prescribed for determining the allowable uplift loads on hip/ridge tiles.

1715.2.2 Wind tunnel testing. When roof tiles do not satisfy the limitations in Chapter 16 for rigid tile, a wind tunnel test shall be used to determine the wind characteristic of the concrete or clay tile roof covering in accordance with SBCCI SSTD 11 and Chapter 15.

❖ The wind tunnel test procedures in SSTD 11 must be used if the roof tiles do not meet the limitations of Chapter 16 for rigid tile.

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