Chapter 3 Commentary

QUALITY ASSURANCE

3.1 SCOPE: Quality assurance (control and verification) for *structures* included in *Seismic Design Categories* C, D, E and F, is necessary do to the complexity of the *seismic-force resistive systems* and is important because of the serious consequences of the failure of *structures*. The level of quality assurance varies with the degree of seismic risk.

Quality Assurance requirements involve many aspects of the total design of *structures* and construction process; from the selection of the design team and their suitability for the project, to the capabilities of the construction contractor(s) and subcontractors, whether selected by qualification or by low bid. When *structures* are to be located in areas with probability of having damaging earthquake ground motion, the risk of loss of life demands adequate quality assurance to assure life safety. Unfortunately, earthquake related failures in recent seismic events that are directly traceable to poor design or quality control during construction are innumerable, and these deficiencies must be eliminated. The earthquake requirements included in the *Provisions* rely heavily upon the concept of adequate quality controls and verifications to ensure sound construction. It is important that all parties involved in the design and construction process understand and support the quality assurance requirements recommended in the *Provisions*.

The technological complexity of the design of modern *structures* necessitates employment of a team of *registered design professionals*. Each member in responsible charge of design of each element or system of the *structure* shall have been qualified and licensed by the jurisdiction to practice in their technical fields of practice. *Structures* located at a site with a potential for having damaging earthquake ground motion, must be designed to withstand the resulting seismic forces and accommodate element displacements.

Every element of a *structure* is a part of a continuous load path transmitting seismic forces from and to the foundations, which must be adequately strengthened and appropriately anchored to resist the seismic forces and accommodate the resulting displacements. Many of the failures in recent earthquakes have been attributed to weak links in the seismic force resisting load paths. Since the interconnection between adjacent elements of the *structure* often involves different *registered design professionals* and different construction trades during installation, it is imperative that these interconnections be adequately described in the *construction documents* and observed during installation. In order to accommodate these constraints and produce a coordinated design the *registered design professionals* must function as an integrated and well coordinated team.

The selection of the size and configuration of the *structure*, and the type of structural *seismic force resisting system(s)* selected (how rigid or ductile), can make a significant impact on the performance of the *structure* in an earthquake. Since the selection can affect the design and cost of construction of almost every element of the *structures*, it is essential that the entire design team be knowledgeable of and participate in these preliminary design decisions and appropriately accommodate them in their design. While not required by the *Provisions*, it is recommended that a *quality assurance plan* be prepared for the design process.

For quality assurance during construction, the following is included in the *Provisions*: (1) the *registered design professional(s)* in responsible charge of the design specifies the quality assurance requirements; (2) the prime contractor(s) exercises the control necessary to achieve the required quality: and (3) the *owner* is responsible for monitoring the construction process through *special inspections*, observations, and testing. It is important that each and every party involved recognizes their responsibilities, understands the procedures, and is capable of carrying them out. Because the contractor and specialty subcontractors are performing the work and exercising control of quality, it is essential that the *special inspections* and tests be performed by someone not in their direct employ. For this reason, the *special inspectors* are the *owner's* inspectors, and serve at the discretion of the authority having jurisdiction. When the *owner* is also the contractor, the *owner*, to avoid a potential conflict of interest, must engage independent agencies to conduct the *special inspections* and tests rather than try to qualify his own employees for that purpose.

The contractual responsibilities during the construction phase, vary from project to project, depending on the *structure*, and the desires of the *owner*. The majority of *building owners* use the standard contract forms published by the American Institute of Architects (AIA) or the Engineers' Joint Contract Documents Committee (EJCDC), or one modeled therefrom, which includes specific construction phase responsibilities.

The *registered design professional* in responsible charge for each portion of the project is the most knowledgeable, and frequently the only person available for assuring appropriate conformance with the intent of the design as conveyed in the *construction documents*. It is essential that a *registered design professional* be sufficiently involved during the construction phase of the project to assure general conformance with the approved *construction documents*. Courts are ruling more frequently that the above responsibilities remain that of the *registered design professional* in responsible charge of the design, regardless of the language included in the contract for professional services.

The quality assurance requirements included in Chapter 3 of the *Provisions* are the minimum requirements. It could be the decision of the *owner* or *registered design professional* to include more stringent quality assurance requirements. The primary method for achieving quality assurance is through the use of *special inspectors* and testing agencies.

Registered design professional(s) in responsible charge, or their employees, may perform the *special inspections*, when approved by the authority having jurisdiction. Increased involvement by the *registered design professional* in responsible charge allows for early detection of problems during construction when they can more easily be resolved.

3.2 QUALITY ASSURANCE: Because of the complexity of design and construction for *structures* included in *Seismic Design Categories* C, D, E and F, it is necessary to provide a comprehensive written *quality assurance plan* to assure adequate quality controls and verification during construction. Each portion of the *quality assurance plan* is required to be prepared by the *registered design professional* responsible for the design of the *seismic-force-resisting system(s)* and other *designated seismic system(s)* that are subject to requirements for quality assurance. When completed, the *quality assurance plan* must be submitted to the *owner*, and to the authority having jurisdiction.

The performance for quality control of the contractors and subcontractors varies project to project. The *quality assurance plan* is an opportunity for the *registered design professional* to delineate the types and frequency of testing and inspections, and the extent of the *structural observations* to be performed during the construction process, to assure that the construction is in conformance with the approved *construction documents*. Special attention should be given in the *quality assurance plan* for projects with higher *occupancy importance factors*.

The authority having jurisdiction shall approve the *quality assurance plan* and shall obtain from each contractor a written statement that the contractor 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. *Special inspections*, in addition to those included in the *quality assurance plan*, may required by the authority having jurisdiction to provided assurance that there is compliance with the approved *construction documents*.

A *quality assurance plan* is not required for some low-rise multi-family dwellings, commercial, mercantile, and office buildings that are included in *Seismic Use Group* I, as indicated in the exception to Sec. 3.2. The exception is also limited to those *structures* that do not have any of the delineated irregularities. Any *structure* that does not satisfy all of the criteria included in the exception or is not otherwise exempted by the *Provisions* is required to have a *quality assurance plan*. It is important to emphasize that this exemption only applies to the preparation of a *quality assurance plan.* All *special inspections* and testing that are otherwise required by the *Provisions* are not exempt and must be performed.

3.3 SPECIAL INSPECTION: *Special inspection* is the monitoring of materials and workmanship that are critical to the integrity of the *structure*. The requirements listed in this section, from foundation systems through cold formed steel framing, have been included in the national model codes of many years. It is a premise of the *Provisions* that there will be an adequate supply of knowledgeable and experienced inspectors available to provide the necessary *special inspections* for the structural categories of work. Special training programs may have to be developed and implemented for the nonstructural categories.

A *special inspector* is a person approved by the authority having jurisdiction as being qualified to perform *special inspections* for the category of work involved. As a guide to the authority having jurisdiction, it is contemplated that the *special inspector* is to be one of the following:

1. A person employed and supervised by the *registered design professional* in responsible charge for the design of the *designated seismic system* or the *seismic-force-resisting system* for which the *special inspector* is engaged.

2. A person employed by an approved inspection and/or testing agency who is under the direct supervision of a *registered design professional* also employed by the same agency, using inspectors or technicians qualified by recognized industry organizations as approved by the authority having jurisdiction.

3. A manufacturer or fabricator of *components*, equipment, or machinery that has been approved for manufacturing *components* that satisfy seismic safety standards and that maintain a *quality assurance plan* approved by authority having jurisdiction. The

manufacturer or fabricator is required to provide evidence of such approval by clearly marking on each *designated seismic system* or *seismic-force-resisting system component* shipped to the construction site.

The extent and duration of *special inspections*, types of testing, and the frequency of the testing must be clearly delineated in the *quality assurance plan*. In some instances the *Provisions* allow *periodic special inspection* versus *continuous special inspection*. When *periodic special inspections* are allowed, the *Provisions* do not state specific requirements for frequency of periodic inspection, but give minimum stages of construction at which inspection is required for a particular category of work. The *quality assurance plan* should generally indicate the timing and extent of any *periodic special inspections* required by the *Provisions*.

3.3.9 Architectural Components: It is anticipated that the minimum requirements for architectural *components* (e.g. exterior cladding) are satisfied when that the method of anchoring *components* and the number, spacing, and types of fasteners actually used conforms with approved *construction documents*. It is noted that such *special inspection* requirements are only for those *components* in *Seismic Design Categories* D, or E, or F.

3.3.10 Mechanical and Electrical Components: It is anticipated that the minimum requirements for mechanical and electrical *components* are satisfied when the method of anchoring *components* and the number, spacing, and types of fasteners actually used conforms with the approved *construction documents*. It is noted that such *special inspection* requirements are for selected electrical, lighting, piping and ductwork *components* in all *Seismic Design Categories* except A and B, and for all electrical equipment in *Seismic Design Categories* E and F.

3.4 TESTING: Compliance with nationally recognized test standards provides the authority having jurisdiction and the *owner* a means to determine the acceptability of materials and their placement. Most test standards for materials are developed and maintained by the American Society of Testing and Materials (ASTM). Through their reference in model building codes and material specifications, ASTM Standards and other standard testing procedures provide a universal measure for acceptance of materials and construction. The *Provisions* and the model building codes require that standard tests be performed by an approved testing agency.

Special inspector(s) are responsible for the observation and verification of the testing procedures performed in the field. Special inspectors determine compliance with test standards based on their interpretation of the standards, as measured against acceptance criteria that are included in the *construction documents* and the *quality assurance* plan.

Test standards also prescribe responsibilities for others. For example, ASTM A 706 specification for low-alloy steel reinforcing bars requires the manufacturer to report the chemical composition and carbon equivalent of the material. In addition, the ANSI/AWS D1.4 Welding Code requires the contractor to prepare written specifications for the welding of reinforcing bars. It is necessary, therefore, that each member of the construction team has a thorough knowledge of the specified test standards that cover their particular work.

3.4.5 Mechanical and Electrical Equipment: The registered design professional should consider requirements to demonstrate the seismic performance of mechanical and electrical *components* critical to the post–earthquake life safety of the occupants. Any requirements should

be clearly indicated on the construction documents. Any currently accepted technology should be acceptable to demonstrate compliance with the requirements.

3.5 STRUCTURAL OBSERVATIONS: The purpose of *structural observations* is to allow the *registered design professional(s)* in responsible charge or other *registered design professional(s)* to visit the site to observe the *seismic-force-resisting systems*. Observations include verifying the *seismic-force-resisting system* is constructed in general conformance with the *construction documents*, and the intent of the design has been accomplished and that a complete lateral load path exists.

Every effort shall be made to have the *registered design professional* in responsible charge make the observations. If another *registered design professional* performs the observations he is expected to be familiar with the *construction documents* and the design concept.

3.6 REPORTING AND COMPLIANCE PROCEDURES: The purpose of this section is to keep parties as delineated in the *Provisions* informed of the *special inspector's* observations and the contractor's corrections.