



**STRUCTURAL ENGINEERS ASSOCIATION
OF NORTHERN CALIFORNIA**

**GUIDELINES
FOR
SPECIAL INSPECTION AND
STRUCTURAL OBSERVATION
*In Accordance With The 1997 UBC***

JUNE 1998

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Guidelines for Special Inspection and Structural Observation In Accordance With The 1997 UBC

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Preface

The purpose of these guidelines is to facilitate a better understanding of the 1997 Uniform Building Code (UBC) requirements for special inspection and structural observation. Commentary is provided for relevant UBC provisions, together with suggestions and sample documents to help the structural engineer, owner, and special inspector develop and implement an appropriate program of special inspection and structural observation.

It is important to note that this is only a guide and is not intended to be used to establish legal responsibilities or a “standard of care.” The standard of care used by the courts is the duty to use the care and skill ordinarily used in similar cases by reputable members of the profession practicing in the same or similar locality under similar circumstances, and to use reasonable diligence and best judgment in the exercise of professional skill and in the application of learning, in an effort to accomplish the purpose for which the engineer was employed. Further, the legalities and precise wording of contractual obligations are beyond the scope of this guide.

The Structural Engineers Association of Northern California (SEAONC) offers this guide to the membership in an advisory capacity and only as an expression of opinion. While the information presented in the document is believed to be correct, SEAONC and its Board and Committees assume no liability for its accuracy or for the opinions expressed herein. The material presented in this document should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability, and applicability by qualified professionals. Users of information presented in this document assume all liability arising from such use.



Introduction

Special inspection is the monitoring of materials and workmanship that are critical to the integrity of the building structure. It helps to ensure compliance with the approved plans and specifications and relevant codes and ordinances. The special inspection process is required by the 1997 Uniform Building Code (UBC) in addition to the inspections conducted by the building department and the periodic structural observation performed by the engineer or architect of record.

The 1994 UBC requirement that the engineer or architect of record develop a program for both special inspection and structural observation represents a significant increase in the engineer's responsibility and involvement over previous editions. This document provides guidelines for meeting these requirements, and recommendations for using special inspection and structural observation as a quality assurance tool.

The "engineer or architect of record" is identified in UBC Section 106.3.4.1 as the entity designated on the building permit application whose duties are "reviewing and coordinating all submittal documents....for compatibility with the design of the building." The intent is that there be only one such entity for each project, and, except on smaller projects, the architect would generally perform that role. Thus the architect would technically be responsible for preparing the inspection program. The engineer, however, should be responsible for the structural items involved. As building departments still typically consider the design engineer to be the engineer of record regardless of the distinction of UBC Section 106.3.4.1, this document is written with the assumption that the engineer responsible for the structural design will prepare the inspection program. For simplicity, the term "engineer," as used in these guidelines, refers to the engineer responsible for the structural design.

The minimum code requirement is that the engineer or architect of record prepare the inspection program and perform any structural observation required. Fees for this work should be included as part of the engineer's services. Some of the quality assurance tools discussed in Chapter 3 of these guidelines go beyond the code requirements and

possibly beyond the scope of the engineer's normal professional services contract. However, the improved construction quality made possible by an active monitoring role in the inspection process should be well worth the engineer's effort to obtain the appropriate additional construction administration fees.

The building official (or the jurisdiction) is the only enforcement entity referred to in these guidelines; much of the information could also apply to county, state, federal, or other governing jurisdiction.

The following 1997 UBC section contains the requirements for the inspection program. Throughout this document, 1997 UBC code language is shown in italics; UBC section numbers shown in brackets indicate the corresponding section from the 1994 UBC in cases where the numbering has changed.

UBC Section 106.3.5 Inspection and observation program. *When special inspection is required by Section 1701, the architect or engineer of record shall prepare an inspection program which shall be submitted to the building official for approval prior to issuance of the building permit. The inspection program shall designate the portions of the work that require special inspection and the name or names of the individuals who are to perform the special inspections, and indicate the duties of the special inspectors.*

The special inspector shall be employed by the owner, the engineer or architect of record, or an agent of the owner, but not the contractor or any other person responsible for the work.

When structural observation is required by Section 1702, the inspection program shall name the individuals or firms who are to perform structural observation and describe the stages of construction at which structural observation is to occur.

The inspection program shall include samples of inspection reports and provide time limits for submission of reports.



Guidelines for Special Inspection and Structural Observation *In Accordance with the 1997 UBC*

SEAONC Construction Quality Assurance Committee

Chapter 1 Special Inspection

1.1 Special Inspection and Testing Schedule

UBC Section 106.3.5 requires the engineer or architect of record to prepare an inspection program and submit it to the building official for approval prior to issuance of the building permit. It is recommended that a Special Inspection and Testing Schedule, summarizing the inspection requirements in sufficient detail to direct the inspectors in the field, appear in the general notes on the structural drawings. This then becomes part of the contract documents to aid the contractor in scheduling and coordinating the inspections. Some jurisdictions provide a blank Special Inspection and Testing Schedule for the engineer to fill out. A sample of such a schedule, expanded to include the level of detail recommended, is included in Appendix A. The checklist format serves as a reminder of the issues to be considered. If more information regarding the details of the required inspections is desired, that information can be included in the technical sections of the project specifications. The specifications should be carefully coordinated with the Special Inspection and Testing Schedule for consistency.

Current practice often includes listing the special inspection items in the general notes and describing the detailed requirements for each item in the project specifications. This may not be considered to constitute an “inspection program” in some jurisdictions.

The schedule provides information to the inspector and the contractor and should include the following:

- The type of inspections required (i.e. reinforcing steel, concrete, structural masonry, welding, high strength bolting, shotcrete, grading, special cases, etc.).
- The extent, frequency, and sequence of any permitted periodic inspection.

1.2 Waiver of Special Inspection

If the construction is of a minor nature, the building official, at the request of the engineer, may waive the requirement for special inspection. Materials and/or specified design strengths which trigger special inspection requirements may have been employed for quality rather than for structural purposes. Building officials look more favorably on such requests when accompanied by documentation including calculations showing low design stresses, test histories for materials, or other supporting information.

1.3 Continuous and Periodic Inspection

1701.6.1 Continuous special inspection. *Continuous special inspection means that the special inspector is on the site at all times observing the work requiring special inspection.*

With few exceptions, special inspection is intended to be continuous. There is, however, no indication in the code language of how much work an inspector can handle. A single special inspector is often assigned to inspect the work of several trades (e.g., high-strength bolting, welding, and fireproofing), more than one worker (e.g., welding), or more than one project in the same fabrication shop (e.g., steel or precast concrete). While less costly, these practices may jeopardize the quality of inspection. The ultimate responsibility for providing an appropriate number of inspectors lies with the inspection agency and the project owner. However, engineers should be aware of this issue and offer their input to the project owner.

1701.6.2 Periodic Special Inspection. *Some inspections may be made on a periodic basis and satisfy the requirements of continuous inspection, provided this*

periodic scheduled inspection is performed as outlined in the project plans and specifications and approved by the building official.

The UBC does not state specific requirements for frequency of periodic inspections but gives minimum stages at which inspection is required for particular disciplines. Periodic inspections should be appropriate to the rate, sequence, and quality of work. The inspection program should generally indicate the timing and extent of any periodic inspections allowed and provide for changes that may be appropriate based on the quality of the work. Information regarding periodic inspection of specific items is discussed further in section 1.5 of these guidelines.

1.4 Approved Fabricators

The special inspection provisions of the code provide an option for approved fabricators to perform work (such as fabrication of structural steel or precast concrete) without the usually required special inspection (Section 1701.7). However, it should never be assumed that a fabricator is approved. Some jurisdictions recognize no approved fabricators; others deal with the situation on a case-by-case basis. Many building officials have been reluctant to establish approved fabricator status due to the additional effort and

liability associated with determining qualifications, monitoring, and enforcing the requirements. Some consider the fabricator prequalification process inadequate due to minimal verification and monitoring of compliance and heavy reliance on the internal quality control procedures.

The three approved fabricator programs for structural steel that are recognized by some California jurisdictions are those administered by ICBO Evaluation Service, the City of Los Angeles, and the American Institute of Steel Construction (AISC).

The experience of many independent testing and inspection agencies suggests that special inspection will usually result in higher quality work due simply to the additional scrutiny it provides. This is true even with an approved fabricator.

1.5 Types of Work Requiring Special Inspection

In the following section, the code language is included in italics in the left hand column. Specific examples for completing Appendix A for each type of work are included in the commentary. The commentary and examples provided are advisory only; actual project requirements may vary.

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1701.5 Types of Work. *Except as provided in Section 1701.1, the types of work listed below shall be inspected by a special inspector.*

1. Concrete. *During the taking of test specimens and placing of reinforced concrete. See Item 12 for shotcrete.*

EXCEPTIONS: *1. Concrete for foundations conforming with Table 18-I-C or for Group R, Division 3 or Group U, Division 1 Occupancies, provided the building official finds that a special hazard does not exist.*

2. For foundation concrete, other than cast-in-place drilled piles or caissons, where the structural design is based on an f_c no greater than 2,500 pounds per square inch (psi) (17.2 MPa).

3. Non-structural slabs on grade, including prestressed slabs on grade when effective prestress in concrete is less than 150 psi (1.03 MPa).

4. Site work concrete fully supported on earth and concrete where no special hazard exists.

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1.5.1 Concrete

Continuous placement inspection and materials testing is required for most reinforced concrete.

Foundations for single-family dwellings, or private garages or other Group U structures, can be excepted unless a special hazard exists. Exception 2 is often not taken advantage of in cases where the engineer specifies a foundation concrete strength exceeding 2500 psi in order to obtain better quality, rather than for reasons of computed strength.

Per UBC Section 1905.6.1.3, concrete strength tests are not required for classes of concrete of which fewer than 50 cubic yards are used if strength documentation is approved by the building official. In this case, placement inspection would still be required.

The Special Inspection & Testing Schedule (Appendix A) should specify the concrete members requiring inspection and the number of samples for strength tests. Two cylinders

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are required for a strength test. The UBC minimum frequency of one strength test (2 cylinders at 28 days old) per 150 cubic yards may not be sufficient for some projects. This is particularly applicable to columns, where relatively small quantities are the norm. It is desirable to test one cylinder at 7 days to get an early indication, test 2 cylinders at 28 days, and to retain one or more cylinders for an additional strength test later if the first one fails to meet specification. More cylinders will be needed if field cured specimens are desired for post-tensioned concrete, tilt-up panels, or for early stripping of forms. Specifying more than the minimum number of test cylinders can also prevent the need for expensive testing of hardened concrete.

Example (See Appendix A):

1. Concrete
 - All Concrete
 - Exceptions: slab-on-grade
 - 4 Cylinders per 150 Cubic Yards*
 - Test: 1 @ 7 days, 2 @ 28 days, 1 hold
 - *Minimum one set for every 5 columns or one set per day

2. Bolts installed in concrete. *Prior to and during the placement of concrete around bolts when stress increases permitted by Footnote 5 of Table 19-D or Section 1923 are utilized.*

1.5.2 Bolts Installed in Concrete

This applies to bolts installed in fresh concrete for which stress increases are utilized. The schedule should indicate specifically which bolts require special inspection.

Example (See Appendix A):

2. Bolts installed in concrete:
 - All Bolts
 - Location: holdowns and shear wall anchor bolts
 (Refer to 1.5.15 for expansion and adhesive anchors.)

3. Special moment-resisting concrete frame. *For moment frames resisting design seismic load in structures within Seismic Zones 3 and 4, the special inspector shall provide reports to the person responsible for the structural design and shall provide continuous inspection of the placement of the reinforcement and concrete.*

1.5.3 Special Moment-Resisting Concrete Frames

The ductile detailing of the joints in these frames requires close coordination between the engineer and the special inspector. Note that continuous inspection is required for placement of reinforcing steel for special moment-resisting concrete frames. The inspection schedule should indicate which members are part of the frame or refer to that information on the plans.

Example (See Appendix A):

3. Special moment-resisting frames:
 - As Indicated
 - Location: all numbered column lines, all floors

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4. Reinforcing steel and prestressing steel tendons.

4.1 During all stressing and grouting of tendons in prestressed concrete.

4.2 During placing of reinforcing steel and prestressing tendons for all concrete required to have special inspection by Item 1.

EXCEPTION: The special inspector need not be present continuously during placing of reinforcing steel and prestressing tendons, provided the special inspector has inspected for conformance to the approved plans prior to the closing of forms or the delivery of concrete to the jobsite.

1.5.4 Reinforcing Steel and Prestressing Tendons

Special inspection of reinforcing steel is required if the accompanying concrete or shotcrete requires special inspection. The exception allows periodic inspection, essentially requiring only inspection of the completed installation. Inspection should begin far enough in advance of any concrete placement to allow a thorough inspection and ensure that any corrections are made.

Stressing and grouting of prestressing tendons requires continuous inspection.

Example (See Appendix A):

- 4. Reinforcing steel and prestressing tendons
 - Placement inspection
 - Stressing and grouting of tendons

5. Structural welding.

5.1 **General.** During the welding of any member or connection that is designed to resist loads and forces required by this code.

EXCEPTIONS: 1. Welding done in an approved fabricator's shop in accordance with Section 1701.7.

2. The special inspector need not be continuously present during welding of the following items, provided the materials, qualifications of welding procedures and welders are verified prior to the start of work; periodic inspections are made of 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 or composite systems.

2.4 Welded sheet steel for cold-formed steel framing members such as studs and joists.

2.5 Welding of stairs and railing systems.

5.2 Special moment-resisting steel frames.

During the welding of special moment-resisting steel frames. In addition to Item 5.1 requirements, nondestructive testing as required by Section 1703 of this code.

5.3 **Welding of reinforcing steel.** During the welding of reinforcing steel.

1.5.5 Structural Welding

The Code requires special inspection for welding "designed to resist loads and forces." This language includes elements that are not part of the structural system, such as cladding connections or stair framing.

Continuous inspection is required except as allowed by the exceptions. The sequence of periodic inspection is detailed in Exception 2, although no specific frequency is indicated for inspection of the work in progress.

Welding Procedure Specifications (WPSs), approved by the engineer, should be available for the inspector. The inspector will review the welder's qualifications, and will inspect for compliance with the WPS.

Section 1703 requires nondestructive testing for fully restrained connections in ordinary and special moment-resisting frames in Seismic Zones 3 and 4, and clearly outlines the minimum requirements of the inspection program. Welds in these connections are the only welds for which the code requires more than visual inspection (the nondestructive testing is in addition to visual inspection). Exception 1 allows a reduction in the rate of nondestructive testing for any welder with a reject rate of less than 5%.

Inspection of welding of reinforcing steel #5 and smaller may be periodic if A706 steel is used. WPSs for all reinforcing steel require qualification by testing. It is recommended that

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EXCEPTION: *The special inspector need not be continuously present during the welding of ASTM A706 reinforcing steel not larger than No. 5 bars used for embedments, provided the materials, qualifications of welding procedures and welders are verified prior to the start of work; periodic inspections are made of work in progress; and a visual inspection of all welds is made prior to completion or prior to shipment of shop welding.*

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welding of reinforcing steel be inspected continuously at any crucial locations.

The inspection schedule should indicate any welding that does not require inspection and list the items of Exception 2 for which the periodic inspections apply, including whether periodic inspection of welding of reinforcing steel will be permitted. The nondestructive testing program for moment frame connections should meet the minimum requirements of Section 1703, using ultrasonic testing, and include any additional testing or inspection desired, such as the FEMA 267 recommendation for using magnetic particle testing at the back-gouged root of a complete penetration weld after removal of the back-up bar.

It is important that any inspection other than visual be clearly indicated, not only to the inspector, but also to the contractor. If nondestructive testing other than visual inspection is requested after contract award, AWS D1.1 makes the project owner responsible for costs associated with repair of defects and with the extra effort required to meet the more stringent acceptance criteria.

Example (See Appendix A):

- 5. Structural Welding
 - Periodic Visual Inspection:
 - Single pass fillet welds < 5/16"
 - Reinforcing steel
 - Continuous Visual Inspection:
 - All other welding
 - Reinforcing steel
 - Special Moment-Resisting Frames:
 - UT all CJP groove welds
 - UT all CJP welds >3/4"
 - UT column flanges at beam flange welds
- (See Appendix A for a complete checklist)

6. High-strength bolting. *The inspection of high-strength A325 and A490 bolts shall be in accordance with approved nationally recognized standards and the requirements of this section.*

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. Such inspections may be performed on a periodic basis in accordance with the requirements of Section 1701.6. The special inspector shall observe the

1.5.6 High-strength bolting

The "approved nationally recognized standards" are the two versions of the "Specification for Structural Joints Using ASTM A325 or A490 Bolts" in the AISC Manuals for allowable stress design (ASD) and load and resistance factor design (LRFD). Each of these almost identical standards explains the installation and inspection procedures.

The selected installation procedure, and the connection design, determines the method of inspection. As a minimum, bolts, nuts, and washers are inspected for conformance with the plans and with handling and storage requirements, and

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calibration procedures when such procedures are required by the plans or specifications and shall monitor the installation of bolts to determine that all plies of connected materials have been drawn together and that the selected procedure is properly used to tighten all bolts.

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parts to be bolted are inspected for surface condition and bolt hole size and configuration.

All types of connections are inspected for the “snug tight” condition. If the design calls for slip-critical or direct tension connections, it should be clearly stated. The bolts will then require tightening (pretensioning) to a specified minimum tension. The AISC specifications detail four methods of tightening, each of which includes either a calibration procedure or a more direct method of determining actual tension.

The calibration procedures for slip-critical bolts require that the contractor provide a tension measuring device (i.e. Skidmore Wilhelm device) to calibrate the installation method for each type, length, and diameter of bolt.

The AISC specifications do not recognize standard torque values determined from tables or formulas relating torque to tension because variations in threads and thread surface conditions significantly affect the torque necessary to achieve the required tension.

The schedule should indicate which connections require full pretension or refer to that information on the drawings (“As Indicated”).

Example (See Appendix A):

6. High Strength Bolting		
Snug tight:	<input type="checkbox"/>	All
	<input checked="" type="checkbox"/>	As Indicated
Full Pretension:	<input type="checkbox"/>	All
	<input checked="" type="checkbox"/>	As Indicated

7. Structural masonry

7.1 For masonry, other than fully grouted open-end hollow-unit masonry, during preparation and taking of any required prisms or test specimens, placing of all masonry units, placement of reinforcement, inspection of grout space, immediately prior to closing of clean-outs, and during all grouting operations.

EXCEPTION: For hollow-unit masonry where the f_m is no more than 1,500 psi (10.34 Mpa) for concrete units or 2,600 (17.93 Mpa) for clay units, special

1.5.7 Structural Masonry

Special inspection for masonry has two components: sampling for testing purposes; and inspection during construction.

Testing of masonry is governed by the specified compressive strength (f'_m), the method used to verify f'_m (UBC Section 2105), and whether full- or half-stresses are used in the design (working stress only). The UBC requires the engineer to specify a compressive strength for the masonry and to show that value on the plans but does not require the engineer to specify which of the three methods for verifying f'_m is to be used (prism testing, prism test record, or unit strength method).

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inspection may be performed as required for fully grouted open-end hollow-unit masonry specified in Item 7.2.

7.2 For fully grouted open-end hollow-unit masonry during preparation and taking of any required prisms or test specimens, at the start of laying units, after the placement of reinforcing steel, grout space prior to each grouting operation, and during all grouting operations.

EXCEPTION: *Special inspection as required in Items 7.1 and 7.2 need not be provided when design stresses have been adjusted as specified in Chapter 21 to permit non-continuous inspection.*

The special inspection schedule should indicate the value of f'_m , specify a method for verification of f'_m , and indicate whether full or half stresses were used in the design. When using masonry with f'_m of greater than 1500 psi (or greater than 2600 psi for clay masonry), it is recommended that prism testing be specified. If the prism test record method is specified, prism testing should be offered as an alternative, since the contractor ultimately chosen to perform the work may not have a record of 30 prism tests.

The table below summarizes the tests required for masonry. Mortar testing, although customary, is not required by the UBC.

Table 1 Testing of Masonry

PRISM TESTING	Prior to Construction		During Construction	
	Full Stresses	Half Stresses	Full Stresses	Half Stresses
All zones, all f'_m	Test 5 prisms	Test 5 prisms	3 prisms/5000 ft ²	Certification only
Zone 3&4, $f'_m > 1500$ for CMU, > 2600 for clay masonry	Test 5 prisms	Test 5 prisms	3 prisms/5000 ft ²	3 prisms/5000 ft ²
PRISM TEST RECORD	Prior to Construction		During Construction	
	Full Stresses	Half Stresses	Full Stresses	Half Stresses
All zones, all f'_m	30 test records	30 test records	3 prisms/5000 ft ²	Certification only
Zone 3&4, $f'_m > 1500$ for CMU, > 2600 for clay masonry	30 test records	30 test records	3 prisms/5000 ft ²	3 prisms/5000 ft ²
UNIT STRENGTH	Prior to Construction		During Construction	
	Full Stresses	Half Stresses	Full Stresses	Half Stresses
Zone 1 & 2 and Zone 3 & 4 w/ $f'_m > 1500$ for CMU, > 2600 for clay masonry	Test units	Certification for units & grout	Test units & grout/5000 ft ²	None
Zone 3&4 w/ $f'_m > 1500$ for CMU, > 2600 for clay masonry	Test units	Certification for units & grout	Test units & grout/5000 ft ²	Test units & grout/5000 ft ²

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7. Structural masonry (Repeated)

7.1 For masonry, other than fully grouted open-end hollow-unit masonry, during preparation and taking of any required prisms or test specimens, placing of all masonry units, placement of reinforcement, inspection of grout space, immediately prior to closing of clean-outs, and during all grouting operations.

EXCEPTION: For hollow-unit masonry where the f_m is no more than 1,500 psi (10.34 Mpa) for concrete units or 2,600 (17.93 Mpa) for clay units, special inspection may be performed as required for fully grouted open-end hollow-unit masonry specified in Item 7.2.

7.2 For fully grouted open-end hollow-unit masonry during preparation and taking of any required prisms or test specimens, at the start of laying units, after the placement of reinforcing steel, grout space prior to each grouting operation, and during all grouting operations.

EXCEPTION: Special inspection as required in Items 7.1 and 7.2 need not be provided when design stresses have been adjusted as specified in Chapter 21 to permit non-continuous inspection.

A typical California masonry building is constructed of fully grouted open-end hollow-unit masonry with f_m of 1500 psi. The inspection requirements during construction are then those listed in paragraph 7.2. This is periodic inspection, as contrasted with the continuous inspection described in paragraph 7.1 where the inspector is present during all of the masonry work.

The exception to paragraph 7.1 allows the periodic inspection of 7.2 to be used for other types of hollow-unit masonry (for example not fully grouted, not open-end units) subject to limitations of f_m . All other types of structural masonry, such as solid masonry or multi-wythe cavity walls (whether grouted or not), require continuous inspection in accordance with paragraph 7.1.

The exception to paragraph 7.2 is generally interpreted to allow masonry to be constructed without any special inspection provided it has been designed by the working stress method using one-half the allowable stresses. Some testing is still required (see UBC Section 2107.1.2 and the foregoing table).

Example (See Appendix A):

7. Structural Masonry: $f'_m = 1500$ psi, full stresses
 Prism Test Prism Test Record Unit Strength

	Before	During
Prisms	<input type="checkbox"/>	<input type="checkbox"/>
Units	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Grout	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Mortar	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Continuous inspection		
<input checked="" type="checkbox"/> Periodic Inspection: <u>once per day</u>		

8. Reinforced gypsum concrete. When cast-in-place Class B gypsum concrete is being mixed and placed.

1.5.8 Reinforced Gypsum Concrete

Although rare, when the higher strength Class B is used (for example in a structural diaphragm), special inspection is required during mixing and placing. The schedule should list any strength testing desired.

Example (See Appendix A):

8. Reinforced Gypsum Concrete
 Mixing and Placement
 Continuous inspection
 Periodic Inspection _____
 Strength Testing: _____

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9. **Insulating concrete fill.** During the application of insulating concrete fill when used as part of a structural system.

EXCEPTION: The special inspections may be limited to an initial inspection to check the deck surface and placement of reinforcing. The special inspector shall supervise the preparation of compression test specimens during this initial inspection.

10. **Spray-applied fire-resistive materials.** As required by UBC Standard 7-6.

11. **Piling, drilled piers and caissons.** During driving and testing of piles and construction of cast-in-place drilled piles or caissons. See Items 1 and 4 for concrete and reinforcing steel inspection.

COMMENTARY

1.5.9 Insulating Concrete Fill

The exception allows periodic inspection in all cases, requiring only an initial inspection. Any sampling and testing for strength or density should be indicated in the schedule.

Example (See Appendix A):

9. Insulating concrete fill
 Periodic Inspection: _____
 Strength Testing: _____

(Consult with the Project Architect on this item)

1.5.10 Spray-Applied Fire Resistive Materials

Special Inspection of fireproofing involves visual inspection of the substrate, observation of the application process, and testing for thickness and density. Other testing, such as adhesion tests if required, should be indicated in the schedule.

Local building departments are currently considering a requirement that the structural plans include a schedule showing fireproofing thickness for each member. As a minimum, the engineer of record may be required to assume the responsibility for identification of the primary and secondary members.

Example (See Appendix A):

10. Spray-applied fire-resistive materials
 Continuous Inspection
 Adhesion tests:

(Consult with the Project Architect on this item)

1.5.11 Piling, Drilled Piers And Caissons

If these items are part of the structural design, UBC Section 1807.1 requires that there be a foundation investigation and report which is to include field inspection and reporting procedures. This report will have been prepared by a Geotechnical Engineer who should be asked to help prepare this part of the special inspection program.

The geotechnical engineer will generally want to inspect all pile driving to verify equipment and record blow counts, and to observe all load testing. For cast-in-place drilled piles, the geotechnical engineer will want to observe most of the drilling operations to verify the soil strata against the data in the report, and, for end bearing piles, to verify cleanliness of the bottom.

UBC SECTION 1701.5

COMMENTARY

Example (See Appendix A):

11. Piling, drilled piers and caissons		
	Continuous	Periodic
Pile driving	<input type="checkbox"/>	<input type="checkbox"/>
Drilling	<input type="checkbox"/>	<input type="checkbox"/>
Testing	<input type="checkbox"/>	<input type="checkbox"/>

* Verify soil strata at toe

12. **Shotcrete.** During the taking of test specimens and placing of all shotcrete and as required by Sections 1924.10 and 1924.11.

EXCEPTION: Shotcrete work fully supported on earth, minor repairs and when, in the opinion of the building official, no special hazard exists.

1.5.12 Shotcrete

UBC Section 1924 [1922] requires continuous placement inspection for structural members and visual inspection of three cores taken from areas of the in-place work that represent the worst congestion of reinforcing bars. The core areas should be prepared in advance with extra reinforcing so that the coring does not cut needed reinforcing. Special inspection can be critical where reinforcing is congested or where proper nozzle orientation is difficult.

A preconstruction test panel representing the most difficult project conditions is required for shotcrete work using reinforcing larger than #5 in order to qualify the materials, processes, and personnel to be used. The details of this panel should be provided by the engineer.

Example (See Appendix A):

12. Shotcrete	
<input checked="" type="checkbox"/> Preconstruction panel	
<input type="checkbox"/> In-place cores	
Strength Testing by:	
<input checked="" type="checkbox"/> Test panel	
<input type="checkbox"/> In-place cores	

13. **Special grading, excavation and filling.** During earth-work excavations, grading and filling operations inspection to satisfy requirements of Chapter 18 and Appendix Chapter 33.

1.5.13 Special Grading, Excavation and Filling

UBC Appendix Chapter 33 (Section 3317) outlines the following “professional inspection” duties: observe that line, grade, and surface drainage conform to the plans; observe the preparation of the existing ground to receive fill; observe fill placement and compaction testing; and verify that the soil strata intended for structural bearing are adequate. The actual details of the inspections, such as number of compaction tests per square yard per lift, are left to the geotechnical engineer, and should be included in the schedule.

Example (See Appendix A):

13. Special grading, excavation and filling	
<input checked="" type="checkbox"/> Subgrade tests: <u>Every 2000 sf</u>	
<input checked="" type="checkbox"/> Compaction tests: <u>Every 2000 sf, each lift</u>	
<input type="checkbox"/> Verify bearing strata	

UBC SECTION 1701.5

COMMENTARY

14. *Smoke-control system.*

14.1 *During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.*

14.2 *Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements, and detection and control verification.*

1.5.14 **Smoke-Control System**

If a smoke-control system is part of the project, it has been designed and detailed by a mechanical engineer who should be asked to help detail the required inspections. Inspection generally involves a sequence of operations negotiated with the local fire department.

Example (See Appendix A):

14. Smoke-control system

- Periodic inspection during ductwork erection
- During system testing

END OF CODE/COMMENTARY FORMAT

1.5.15 **Special Cases**

UBC Section 1701.5.15 identifies special cases as *work that, in the opinion of the building official, involves unusual hazards or conditions.*

Local building department amendments may identify some such items, and the engineer should consider if there are others which are crucial to the structural system. Some examples of items to be considered for the special inspection program include:

Anchorage to existing concrete or masonry.

Anchorage to concrete or masonry in drilled holes using cementitious grout, adhesives or expansion anchors is very sensitive to workmanship, particularly for tension loading.

ICBO Evaluation Reports for proprietary adhesive anchors mandate special inspection and, while not always consistent, generally detail the requirements. The inspection is continuous and includes verification of the drill bit, hole depth and cleanliness, anchor diameter and length, and adhesive brand, mixing and installation. Direct tension testing of adhesive anchors may also be required by the jurisdiction but is not a substitute for the required continuous special inspection.

OSHPD Code Application Notice for the 1995 California Building Code Section 1925.A.3.5 (formerly Interpretation of Regulations IR 26-6) requires special inspection of adhesive anchors during installation and during tension testing to ensure strict compliance with the ICBO evaluation report. Torque testing is not allowed.

ICBO Evaluation Reports for expansion anchors give different allowable tension loads for anchors installed with and without special inspection, and generally detail the inspection requirements. Continuous inspection of the installation of the expansion anchors, similar to that described above for adhesive anchors, is required. However, since ICBO requires a length identification symbol on anchors available in multiple lengths, a program of after-the-fact visual inspection, combined with torque or tension testing, could be specified as an alternative. The OSHPD Code Application Notice referenced above details the testing requirements of such a program.

The schedule should detail the inspection required and the plans should indicate any required testing loads.

Shear wall/diaphragm nailing. Nailing inspection is not required by the UBC. Machine nailing has made nailing fast and easy, but workmanship problems such as nails too close to the edge, nails that miss the framing below, and over-driven (through the surface ply) nails are common. Specify a machine nailing qualification mock-up and include diaphragm nailing, collector nailing, and framing clip, hold-down and structural connection inspection in the special inspection schedule for wood framed buildings in Seismic Zones 3 and 4.

Shoring and underpinning. Load testing of tiebacks (rock bolts, rock anchors, soil anchors), transfer of building load to underpinning, and preloading of bracing struts and rakers should be indicated in the schedule.

1.6 **Selecting a Special Inspection Agency**

The project owner, or the engineer or architect of record acting as the owner's agent, is required to pay for special

inspection services. The engineer should be consulted regarding the selection of the special inspection agency and is required to indicate in the inspection program the name of the persons or agencies selected.

In some jurisdictions, the engineer or architect of record may personally perform special inspection for the disciplines in which the person is qualified, provided continuous inspection is performed where required. Other jurisdictions consider it a conflict of interest for the design professional to perform special inspection.

The UBC requires that special inspectors be able to demonstrate competence to the building official for each type of special inspection they perform. Some jurisdictions define who can act as special inspectors by code amendment and/or established approval procedures. In any case, the building official must approve the special inspection agency or agencies selected. Most jurisdictions maintain a list of pre-approved special inspection agencies.

1.6.1 Selection Criteria

Cost

Special inspection is an owner's cost often overlooked in the budgeting. Pricing of these services is difficult because special inspection agencies have no control over the schedules and quantities on which they must base cost estimates. Although the required total inspection effort can be determined in a general way from project size, duration and design, the contractor's scheduling practices and the quality of the work can have a large effect on the actual inspection costs.

Owners want fixed fee proposals which agencies are reluctant to give, preferring hourly contracts. Typically agencies will estimate the work effort, indicate their hourly rates and costs per test, and show an estimated total cost. A prepared format containing project schedule and quantity information, such as the example Request for Proposal (RFP) and Cost Estimate included in Appendix D, is one way to avoid confusion in comparing costs. This RFP should also offer agencies opportunities to demonstrate other capabilities by describing how they will handle various aspects of the project inspection and testing, so that cost is not the only consideration.

Total costs for special inspection/testing can cover a wide range. In metropolitan areas, costs are generally 0.25% to 1% of the project shell valuation.

Agency Qualifications

Selection of special inspection agencies should be based not only on cost but also on the qualifications of the agency and its personnel for the special inspection and materials testing requirements of the specific project.

The standard of the industry for agency qualification is ASTM E329, which requires that special inspectors be under the supervision of a "registered engineer who is a full-time employee of that agency with at least five years engineering experience in testing and inspection of construction material." ASTM E329 also makes it "the responsibility of the agency to ensure that it performs only tests and inspections, or both, for which it is adequately equipped and staffed, and that its employees perform only tests and inspections, or both, for which they are adequately trained."

The selection of a special inspection agency should include the following considerations.

- Project Size and Complexity - The agency should have experience with similar projects.
- Inspection Staffing - The agency should have sufficient qualified inspectors in relevant disciplines.
- Site Location - Agency facilities should be a reasonable distance from the job-site.
- Offsite Inspection - The agency should have capabilities for providing offsite inspection.

Staffing Plan

How an agency plans to staff a project can be an important factor. Particularly complex projects can benefit from having a "lead inspector" and a degree of continuity of field personnel. Subcontracting of inspection work, or the use of multiple prime agencies to handle offsite fabrication are practices that should be discussed prior to selecting an inspection agency. It is recommended that a single agency be ultimately responsible for the special inspection work.

1.6.2 Selection Procedures

The selection process can be as simple as choosing a known and trusted firm or as painstaking as a Request for Qualifications/Request for Proposals search effort. Examples of a Request for Qualifications and a Request for Proposals for a major project are included as Appendix C and Appendix D. The intent is for Appendix D to be filled out by the special

inspection agencies responding to the RFP so that owners will be comparing similar proposals for the project.

1.6.3 Special Inspection & Testing Agreement

The building official, who must approve the special inspectors selected, may require documentation that an agreement exists between the owner and the approved inspectors. Some jurisdictions require a Special Inspection & Testing Agreement, signed by all applicable parties, outlining their respective responsibilities. A sample form, developed as part of the International Conference of Building Officials' "Model Program for Special Inspection," is included as Appendix B. The language of this sample agreement should be carefully reviewed prior to use.

1.7 Special Inspection Reports

The UBC requirement that the inspection program include samples of inspection reports may not be applicable in jurisdictions where review of such samples is part of the special inspection agency approval process. A sample of the selected agency's standard forms should be adequate.

Special inspection progress reports should contain, as a minimum, the following information:

- Project address
- Building permit number
- Date of inspection
- Name of inspector and hours worked
- Description of inspections made including location (referencing approved plan grid lines)
- List of tests performed, if any (and by whom if not the special inspector)
- Statement that work inspected was in accordance with approved plans and specifications
- List of items requiring correction and identification of individuals advised of corrective action
- Correction of previously listed items
- Previously listed uncorrected items

- List of changes to approved plans authorized by architect or engineer

The inspection program must indicate a time limit for submission of reports. The standard of the industry for preparation and submission of reports is about 2 weeks from the date of inspection. This time limit, of course, does not apply to the requirement for immediate notification of the contractor of any noncomplying work, or notification to the engineer and building official if noncomplying work is not corrected.

Chapter 2 Structural Observation

The code sections containing the requirements for structural observation are shown in italics below:

UBC Section 220. STRUCTURAL OBSERVATION
means the visual observation of the structural system, for general conformance to the approved plans and specifications, at significant construction stages and at completion of the structural system. Structural observation does not include or waive the responsibility for the inspections required by Section 108, 1701, or other sections of this code.

UBC Section 1702. STRUCTURAL OBSERVATION
Structural observation shall be provided in Seismic Zone 3 or 4 when one of the following conditions exists:

- 1. The structure is defined in Table 16-K as Occupancy Category I, II, or III,*
- 2. The structure is required to comply with Section 403,*
- 3. The structure is in Seismic Zone 4, N_a as set forth in Table 16-S is greater than one, and a lateral design is required for the entire structure,*

EXCEPTION: *One- and two-story Group R, Division 3 and Group U Occupancies and one- and two-story Groups B, F, M, and S Occupancies.*

- 4. When so designated by the architect or engineer of record,*
- 5. When such observation is specifically required by the building official*

The owner shall employ the engineer or architect responsible for the structural design, or another engineer or architect designated by the engineer or architect responsible for the structural design, to perform structural observation as defined in Section 220. Observed deficiencies shall be reported in writing to the owner's representative, special inspector, contractor and the building official. The structural observer shall submit to the building official a written statement that the site visits have been made and identifying any reported deficiencies that, to the best of the structural observer's knowledge, have not been resolved.

The UBC specifically differentiates between structural observation and special inspection. Structural observation focuses on the building's structural system rather than on the use of particular materials or processes. It is performed by the design engineer or architect, is noncontinuous, and uses visual means only to determine if the construction is in general conformance with the intent of the plans and specifications. Special inspection is generally continuous, and involves a detailed focus on materials, workmanship, and processes. The goal of special inspection is to verify compli-

ance with the plans, specifications, and the governing code.

When structural observation is required, the inspection program must indicate who will perform it, and at what stages of construction.

2.1 Conditions Requiring Structural Observation

The conditions which require structural observation are based on the structure's occupancy category, design, and location. In addition to these conditions, Section 1702 allows the "architect or engineer of record" to require structural observation. The authority to require structural observation is then not necessarily in the hands of the "engineer or architect responsible for the structural design." If the architect is designated as the architect of record on the building permit, and structural observation is not required under the other conditions of Section 1702, the engineer should ask the architect to require structural observation if there are crucial or complex lateral load resisting elements. This will necessitate that the owner pay for the services, and will require the engineer or another engineer designated by him/her to perform the services.

2.2 Sequencing of Site Visits

Determination of when to make site visits is left up to the architect or engineer of record, who includes that information in the inspection program. The building official, who reviews and approves the plan, can ask for more site visits or site visits at other stages of construction than those proposed.

Engineering judgment and knowledge of the crucial lateral load-resisting elements and load paths should determine the stages of construction at which structural observation site visits will be made. The examples listed below are general recommendations only. Sequencing of site visits for actual projects may vary.

2.2.1 Foundations

- Prior to the first concrete pour, but after placement of reinforcing is well under way. Coordinate the site visit with the special inspector to discuss areas of particular concern such as highly congested areas or any mechanically coupled splices and to check that approved placing plans are being used. Discuss anchor bolt placement and placement of hold-down bolts or steel embeds with the general contractor.

- Sometime after the first foundation concrete pour but before the foundation work is completed.

2.2.2 Steel Framing

- After the first tier, i.e., to the first column splice, has been erected and plumbed, and bolt tightening and joint welding is under way. Observe the work in progress and try to meet with the special inspectors for the welding and bolt tightening operations. Pay particular attention to the procedures used for welding of moment frame joints. Review with the special inspector the Welding Procedure Specification in use on a particular joint, and discuss how its provisions are being followed.
- After one level of steel deck is in place and welding of shear studs is underway. Check that welding procedures have been qualified by the inspector on the job.

2.2.3 Wood Framing

- Since the UBC does not require special inspection of wood framing, structural observation site visits may be the only form of quality assurance for the lateral system. Consider adding requirements for special inspection of shear wall/diaphragm, sole plate, and collector nailing, plus installation of framing hardware, to the inspection program.
- After the placement of floor joists but before the installation of first floor sheathing. Observe that joists are doubled where required, additional joists needed to transfer shear are in place, and that framing clips have been installed. This is particularly important where the ground level floor is framed over a crawl space. This is a good time to discuss machine nailing with the general contractor, and to establish criteria for unacceptable nailing such as over-driven or misplaced nails.
- After completion of nailing of the first horizontal diaphragm. Observe nailing. If special inspection was called for, this would be a good time to meet the special inspector in the field.
- After the start of wall framing but before the installation of wall finishes. Observe hold-down post or multiple-stud size and placement, and verify that stud width is adequate for tight nail spacing. Discuss the contractor's schedule for completion of sole plate nailing and hold-down placement for shear walls, as these areas may be covered before the next inspection.

- After the installation of shear wall sheathing, hold-down, and framing connections. This may require several site visits due to the contractor's sequencing of the work. Make it clear that the engineer has the option to observe nailing, hold-downs, and connections.
- Prior to roofing. Observe nailing of the roof diaphragm.
- Prior to interior close-up.

2.2.4 Concrete Construction

- Prior to close-up of the first level column or wall forms.
- For concrete moment frames, after placement of reinforcement has started and again prior to close-up of column or beam forms. Meet with the special inspector to make sure the inspection is continuous and that the inspector is aware of the critical areas around the joints. Establish lines of communication to assure notification regarding field problems such as reinforcement interference or utility penetrations in critical areas.
- During placement of slab/beam/joist reinforcement or post-tensioning tendons. The engineer may elect to personally observe concrete placement for critical structural elements.

2.2.5 Masonry Construction

- During lay-up of the first section of wall with special reinforcement requirements, such as boundary elements. Special inspection may not include full time inspection of lay-up or reinforcement placement, so it may be important to verify that reinforcement is placed with the appropriate positioners.
- Prior to grouting of the first lift. Verify that the special inspector is performing the required special inspections and that elements for connection of other framing are in place.

2.3 Structural Observation Reports

Although the code only requires that observed deficiencies be reported in writing, a report should be prepared and distributed for each structural observation site visit. The report should be identified as a Structural Observation Report, and should indicate the stage of construction, what locations and operations were observed, and any deficiencies noted. Other information, such as weather conditions or reports of conversations with the contractor or inspector, can be a useful part of the record.

Chapter 3 Construction Quality Assurance

The engineer's role in the special inspection process need not end with the code-mandated preparation of the inspection program. The following sections outline ways the engineer can help maximize the quality assurance of special inspection and structural observation. The suggestions in this chapter are offered in an advisory capacity and only as an expression of opinion. This chapter does not define a standard of practice.

3.1 Before Construction

3.1.1 Information on the Plans and Specifications

The contract plans and specifications are essentially instructions to, and information for, the contractor. The following should be included among the instructions:

“Schedule and coordinate all special inspections. Notify the special inspector at least 48 hours prior to performing any work requiring the inspector's presence. Provide access to the work, cause the work to remain exposed for inspection, and pay all costs associated with uncovering any work that has been covered without inspection.”

Specific information, such as materials strengths, or tension test values, that the contractor needs to perform the work, and that the inspectors need to inspect the work should be included in the contract documents rather than in the inspection schedule which may not become part of the contract documents.

Some materials tests, such as those required for unidentified structural steel or reinforcing, are not part of the special inspection work and should be paid for by the contractor. This should be clarified in the specifications.

Specifications may require the contractor to be responsible for additional special inspection costs caused by the contractor's approach to fabrication, subcontracting, or scheduling, such as the use of distant or multiple fabrication shops, or excessive overtime work. Such a requirement could also result in higher fabrication costs and higher bid costs.

3.1.2 Preconstruction Meeting

Projects often have problems regarding special inspection if the parties involved are unfamiliar with requirements. A preconstruction meeting is an excellent way to avoid

problems during the work and delays in compliance approval at project completion. It would be ideal to have a preconstruction conference for every project. Attendees should include at a minimum the architect, engineer of record, special inspectors, and the contractor.

An agenda for such a meeting should include the following:

- Project special inspection requirements - Emphasize areas of special concern. Clarify any areas where the special inspector is not sure of the requirements, particularly the extent of any periodic inspection.
- Submittals - Discuss the schedule for submission of contractor-generated submittals pertinent to the special inspection process, such as mix designs and welding procedure specifications.
- Scheduling - Identify who is responsible for scheduling inspections.
- Approved plans - Make sure that a set of approved plans stamped by the governing jurisdiction is available to special inspectors at the job-site, preferably an additional set for their exclusive use; and that design plans and shop drawings reviewed by the engineer and/or jurisdiction are available at offsite fabrication locations. Emphasize that inspection is to be based on approved plans and specifications and not on shop drawings. If an additional set of plans is provided for special inspectors, procedures for comparing that set with the approved and updated set should be established.
- Jurisdiction contact - Obtain the name and phone number of the person the special inspector should contact to report work being covered without special inspection or other problems requiring building department intervention. Encourage communication between jurisdiction building inspector and special inspector.
- Structural engineer contact - Specify conditions requiring notification and/or approval of structural engineer.
- Drawing revisions - Outline method for handling changes from approved plans.
- Problem resolution - Delineate procedures and lines of communication for dealing with problems. Emphasize

that noncompliance reports should be resolved by the contractor, with input from the engineer if necessary, and the inspector should verify the corrected work.

- Offsite work - Define and discuss any work requiring special inspection which will be performed at a location other than the job-site.
- Subcontracting - Identify any special inspection which will be subcontracted by the lead agency, outline procedures for performance auditing, and verify jurisdiction approval.
- Reports - Define content, time frame, and distribution requirements.
- Verify procedure for final special inspection compliance approval.

3.2 During Construction

Communication during construction between the contractor, engineer, special inspectors, and the building official can be an effective quality assurance tool, provided that each understands and respects the role of the others. The contractor is in control of the progress and scheduling of the work. The engineer is responsible for the structural design. The inspector inspects for compliance and prepares reports. The building official oversees the process and can approve submitted revisions to the construction documents.

The crucial communications that need to take place are: scheduling of the inspections (contractor to inspector); notification of non-compliant items (inspector to contractor, and if not corrected, to engineer and building official); engineer review of non-compliant items (engineer to contractor, inspector and building official); changes in the plans (engineer or architect of record to contractor, inspector, and building official). The engineer is also required to report any deficiencies noted during structural observation site visits to the owner, special inspector, contractor, and building official.

Direct and immediate communication, such as a telephone call or a fax, is advised in reporting non-compliant items. If procedures for these kinds of communications were not set up at a preconstruction meeting, the engineer should initiate contact with the contractor and the special inspector.

3.2.1 Reports

Special inspection progress reports and materials test reports are communications from the inspector. Reports of

site observations, memos regarding acceptable fixes, responses to a Request for Information (RFI), and clarification sketches are the engineer's communication and are often used and accepted as documentation of his/her approval of changes in the work.

The engineer should review inspection reports to make sure that the requested inspections or tests were performed and that the work and materials meet the specifications. Special attention should be paid to any items listed as not in compliance with the approved plans. Once notified of a non-compliant item, the engineer should investigate the situation and offer a potential resolution of the issue. Care should be taken to distinguish between non-compliant work and work that is simply not completed.

An active quality assurance role should include tracking the construction according to the contractor's schedule, coordinating with special inspectors and monitoring their activities, and reviewing the inspection reports in a timely manner.

3.2.2 Changes in the Approved Plans

Changes in the work should take the form of amendments to the existing documents. The revised documents may require building department approval and may also indicate revised special inspection requirements. Copies should be provided to the design engineer, building inspector, contractor, and special inspector.

Minor changes are often noted by the engineer on shop drawings, or in a response to a RFI, or in other informal ways. It is important that this information be made available to the special inspectors. Since the inspector is required by the language of Section 1701.2 to observe the work "for conformance with the approved design drawings and specifications," the inspector's report may indicate that inspection was based on documents not approved by the building official.

The building official may require that even minor changes be submitted as a stamped detail change, signed field memo, or letter verifying engineer's approval.

Chapter 4 Final Reports

The recommendations in this chapter are offered in an advisory capacity and only as an expression of opinion. This chapter does not define the standard of practice for preparation of final reports.

4.1 Special Inspection Final Report

Final reports are required from each agency providing special inspection, including the engineer, if applicable.

Some jurisdictions require a final report for grading, excavation, or engineered fill, and for underpinning or shoring, before foundation construction starts; and for piling, drilled piers, or caissons before start of any work above grade.

Final reports are typically in the form of a letter which should use the code language of Section 1701.3 to state that "work requiring special inspection was, to the best of the inspector's knowledge, in conformance with the approved plans and specifications and the applicable workmanship provisions of this code." Items for which the agency/individual provided special inspection should be listed.

Items not in conformance, unresolved items or any discrepancies in inspection coverage should be noted on the final report as exceptions and described in detail.

Many discrepancies in special inspection reports are minor changes made to accommodate field conditions and approved verbally by the engineer or architect of record. These will often not be noted in the final report if written documentation by the engineer has been provided previously.

The building official may require that any exceptions or discrepancies that are listed in the final report be resolved, usually by the engineer, before the report is accepted.

Some jurisdictions also ask the engineer or architect of record for a stamped final report or "sign-off" letter, covering all the special inspections in a general way. This is not a UBC requirement. If such a certification is mandatory, it should be carefully worded to avoid giving the impression that the engineer is providing a guarantee that the work was performed in complete compliance with the plans and specifications. The following language might be appropriate: "Based upon our review of testing and inspection reports and job site observations, to the best of our knowledge the project has been constructed in general conformance to the intent of the contract documents."

4.2 Structural Observation Final Report

The final report is a letter, stating "that the site visits have been made and identifying any reported deficiencies that, to the best of the structural observer's knowledge, have not been resolved" (Section 1702.5). The building official will generally require the letter to bear the engineer's stamp.

Documentation of the resolution of any items that had been reported by the structural observer during construction should be provided, if not already submitted. The final report should list any item for which resolution could not be obtained. An important structural discrepancy that is not resolved may prevent the owner from obtaining an occupancy permit, or may result in payments to the contractor being withheld.

SPECIAL INSPECTION AND TESTING SCHEDULE

APPENDIX A

1. Concrete

- Continuous placement inspection
- Exceptions _____
- _____ Cylinders per _____ CY
- Test: _____ @7 _____ @28 _____ Hold

2. Bolts installed in concrete

- All bolts
- Location: _____

3. Special moment-resisting concrete frame

- As Indicated
- Location: _____

4. Reinforcing steel and prestressing tendons

- Placement inspection
- Stressing and grouting of tendons

5. Structural Welding

- Periodic Visual Inspection:
- Single pass fillet welds < 5/16"
 - Steel deck
 - Welded studs
 - Cold formed studs and joists
 - Stair and railing systems
 - Reinforcing steel
- Continuous Visual Inspection
- All other welding
 - Reinforcing steel
 - Other _____
- Special moment-resisting frames:
- UT all CJP groove welds
 - UT all CJP groove welds > 5/16"
 - UT all PP groove welds in column splices
 - UT all PP groove welds in column splices > 3/4"
 - UT column flanges at beam flange welds
 - NDT rate reduction per UBC 1703.1 applies
 - Other _____

6. High strength bolting

- Snug Tight: All
 As Indicated
- Full Pretension All
 As Indicated

7. Structural Masonry $f'_m =$ _____, Stresses _____

- Verification of f'_m : Prism tests _____
 Prism test record
 Unit strength
- Continuous inspection
 - Periodic inspection: _____

7. Structural masonry (continued)

- | | | |
|--------|--------------------------|--------------------------|
| Test: | Before | During |
| Prisms | <input type="checkbox"/> | <input type="checkbox"/> |
| Units | <input type="checkbox"/> | <input type="checkbox"/> |
| Grout | <input type="checkbox"/> | <input type="checkbox"/> |
| Mortar | <input type="checkbox"/> | <input type="checkbox"/> |

8. Reinforced gypsum concrete

- Continuous inspection of mixing and placement
- Periodic inspection _____
- Strength testing _____

9. Insulating concrete fill

- Periodic inspection _____
- Strength testing _____

10. Spray-applied fire resistive materials

- Periodic inspection _____
- Testing per UBC Std. 7-6

11. Piling, drilled pier and caisson

- | | | |
|--------------|--------------------------|--------------------------|
| | Continuous | Periodic |
| Pile Driving | <input type="checkbox"/> | <input type="checkbox"/> |
| Drilling | <input type="checkbox"/> | <input type="checkbox"/> |
| Testing | <input type="checkbox"/> | <input type="checkbox"/> |

12. Shotcrete

- Continuous placement inspector
 - Preconstruction panel
 - In-place cores
- Strength testing:
- Test panel
 - In-place cores

13. Special grading, excavation, and filling

- Periodic Inspection
- Subgrade tests _____
- Compaction tests _____
- Verify bearing strata

14. Smoke control systems

- Periodic inspection during ductwork erection
- During system testing

15. Special cases

- Shear wall/diaphragm nailing
- Anchorage to existing concrete/masonry
 - Installation inspection
 - Proof load testing
- Shoring
- Underpinning

Notes:

ICBO MODEL PROGRAM FOR SPECIAL INSPECTION

SPECIAL INSPECTION AND TESTING AGREEMENT

To permit applicants of projects requiring special inspection &/or testing per Uniform Building Code Sec. 1701.5:
Project Address: _____ Permit No.:

BEFORE A PERMIT CAN BE ISSUED: The owner, or the engineer or architect of record, acting as the owner's agent, shall complete two (2) copies of this agreement and the attached Special Inspection and Testing Schedule, including the required acknowledgments. A pre-construction conference with the parties involved may be required to review the special inspection requirements and procedures.

APPROVAL OF SPECIAL INSPECTORS: Special inspectors may have no financial interest in projects for which they provide special inspection. Special inspectors shall be approved by the building department prior to performing any duties. Special inspectors shall submit their qualifications and are subject to personal interviews for prequalification. Special inspectors shall display approved identification, as stipulated by the building official, when performing the function of special inspector.

Special inspection and testing shall meet the minimum requirements of the Uniform Building Code Section 1701. The following conditions are also applicable:

A. Duties and Responsibilities of the Special Inspector

1. **Observe work.** The special inspector shall observe the work for conformance with the building department approved (stamped) design drawings and specifications and applicable workmanship provisions of the Uniform Building Code. Architect/engineer-reviewed shop drawings may be used only as an aid to inspection. Special inspections are to be performed on a continuous basis, meaning that the special inspector is on site in the general area at all times observing the work requiring special inspection. Periodic inspections, if any, must have prior approval based on a separate written plan reviewed and approved by the building department and the architect or engineer of record.
2. **Report nonconforming items.** The special inspector shall bring nonconforming items to the immediate attention of the contractor and note all such items in the daily report. If any item is not resolved in a timely manner or is about to be incorporated in the work, the special inspector shall immediately notify the building department by telephone or in person, notify the engineer or architect, and post a discrepancy notice.
3. **Furnish daily reports.** On request, each special inspector shall complete and sign both the special inspection record and the daily report form for each day's inspections to remain at the job-site with the contractor for review by the building Inspector.
4. **Furnish weekly reports.** The special inspector or inspection agency shall furnish weekly reports of tests and inspections directly to the building official, engineer and architect of record, and others as designated. These reports are to include the following:
 - a. Description of daily inspections and tests made with applicable locations;
 - b. Listing of all nonconforming items;
 - c. Report on how nonconforming items were resolved or unresolved as applicable; and
 - d. Itemized changes authorized by the architect, engineer and building official if not included in nonconformance items.
5. **Furnish final report.** The special inspector or inspection agency shall submit a final signed report to the building official stating that all items requiring special inspection and testing were fulfilled and reported and, to the best of his/her knowledge, in conformance with the approved design drawings, specifications, approved change orders and the applicable workmanship provisions of the Uniform Building Code. Items not in conformance, unresolved items or any discrepancies in inspection coverage (i.e., missed inspections, periodic inspections when continuous were required, etc.) shall be specifically itemized on an addendum to this report.

B. Contractor Responsibilities

- 1. **Notify the special inspector.** The contractor is responsible for notifying the special inspector or agency regarding individual inspections for items listed on the attached Schedule and as noted on the building department approved plans. Adequate notice shall be provided so the special inspector has time to become familiar with the project.
- 2. **Provide access to approved plans.** The contractor is responsible for providing the special inspector access to approved plans at the job-site.
- 3. **Retain special inspection records.** The contractor is also responsible for retaining at the job-site all special inspection records submitted by the special inspector upon request.

C. **Owner Responsibilities.** The project owner or the engineer or architect of record acting as the owner's agent is responsible for funding special inspection services [ref. UBC Sec.1701.5].

D. Designer Responsibilities

- 1. **Complete the Special Inspection & Testing Schedule.** The engineer or architect of record shall specify special inspection required in the construction documents and list these items on the Special Inspection & Testing Schedule on the plans.
- 2. **Respond to field discrepancies.** The engineer or architect of record shall respond to uncorrected field deficiencies in design, material, or workmanship observed by the special inspector.
- 3. **Document verbal approval of deviation from approved plans.** The engineer or architect of record shall submit to the building official and to the special inspection agency written approval of any verbally approved deviations from the approved plans.
- 4. **Submit design changes.** The engineer or architect of record is responsible for any design changes, in addition to acknowledgment and approval of shop drawings which may detail structural information, and for submission of such changes to the building official for approval.

E. Building Department Responsibilities

- 1. **Approve special inspection.** The building department shall approve all special inspectors and special inspection requirements.
- 2. **Enforce special inspection.** Work requiring special inspection and the performance of special inspectors shall be monitored by the building inspector. His/her approval must be obtained prior to placement of concrete, covering of structural steel, or other similar activities in addition to that of the special inspector.
- 3. **Issue Certificate of Occupancy.** The building official may issue a Temporary Certificate of Occupancy or a Certificate of Final Completion and Occupancy after all special inspection reports and the final compliance report have been submitted and accepted.

ACKNOWLEDGMENTS

I have read and agree to comply with the terms and conditions of this agreement.

Owner:

_____ By: _____ Date: _____

Project Engineer/Architect:

_____ By: _____ Date: _____

Soils Engineer:

_____ By: _____ Date: _____

Contractor:

_____ By: _____ Date: _____

Special Inspector or Inspection Agency:

_____ By: _____ Date: _____

ACCEPTED FOR THE BUILDING DEPARTMENT

By: _____

Date: _____

**REQUEST FOR QUALIFICATIONS
SPECIAL INSPECTION & TESTING
for [Project Name & Location]**

The proposal shall include [number of] sets of the following:

1. A letter of interest, maximum 5 pages, outlining the agency's capabilities, experience, staffing levels and significant accomplishments, and indicating if the agency is currently approved by the [building department] to perform special inspections in [the governing jurisdiction].
2. A copy of the certificate of recognition from the joint Special Inspection Committee of the Peninsula, East Bay, and Monterey Bay ICBO chapters, OR the additional documentation in items 14-19 below.
3. A resume and work history of all key management and supervisory personnel associated with the proposal, identifying registered engineer(s) responsible for inspection and testing activities.
4. An organizational chart for the agency.
5. A matrix list of all inspectors showing inspection areas for which they are qualified and certified.
6. Resumes for all inspectors proposed for the project.
7. A list and fee schedule of all special inspection and testing services and related professional services which the agency can provide in response to this proposal.
8. A list of at least three projects of similar size and complexity for which the agency has performed various special inspection and testing services. Include location of project, description of project, client, engineer of record, contractor, size and cost of project, dates of construction, specific services performed, reviewing agencies involved, and principal/key staff involved.
9. A description of current projects for which the agency is providing services to provide an idea of the remaining resources.
10. If the proposer is a joint venture, a detailed explanation of the responsibility of each agency. Show the number and discipline of personnel in each agency's local office and assignments to this specific project.
11. Location of home office(s) and the office(s) where work will be carried out. Provide breakdown of location by type of work.
12. An explanation of the agency's invoicing and cost accounting procedures for the project.
13. Description of items requested in the Request for Proposal regarding how the agency will handle certain inspection activities.

For agencies *not* recognized by the Special Inspection Committee, provide the following additional items:

14. For item 3 above, require that registered engineers provide evidence of experience per ASTM E329 paragraph 7.2.1: "...*The person shall be a registered engineer and a full-time employee of that agency. The person shall have at least five years engineering experience in testing and inspection of construction materials*". Resumes must be very specific in showing a minimum of five years experience in inspection and materials testing.
15. For item 4 above, evidence of compliance with experience qualifications per California Council of Testing and Inspection Agencies (CCTIA) guidelines, copies of applicable ACI and ICBO certifications and renewals, and copies of fronts and backs of ID cards for all inspectors proposed for the project.
16. Explanation of how job-site supervision will be achieved by the agency responsible engineer.
17. A copy of the latest Concrete and Cement Reference Laboratories (CCRL) Inspection Record and documentation of how deficiencies were corrected.
18. Sample copies of inspection reports, lab reports, and final compliance report prepared for previous clients.
19. Statements from the responsible engineer(s) acknowledging that:
 - A. He/she is the full-time employee responsible for supervision of employees to assure that all local building code requirements are followed by the agency and its employees.
 - B. Special inspectors will perform in accordance with UBC Sec. 1701.3; and that they will be properly qualified, certified, and identified for the specific type(s) of work they will perform.
 - C. Testing and inspection services will be performed in compliance with procedures specified in ASTM E329, in particular, paragraph 10.1: "*It shall be the responsibility of the agency to ensure that it performs only tests and inspections, or both, for which it is adequately equipped and staffed, and that its employees perform only tests and inspections, or both, for which they are adequately trained.*"

Contract Award

The award of the contract will be to the agency whose proposal complies with all of the requirements prescribed and presents documentation of the best overall qualifications to provide services for the project in the most capable, efficient and economical manner.

Example
REQUEST FOR PROPOSALS & COST ESTIMATE
SPECIAL INSPECTION & TESTING
for Tourist Hotel, 100 Any Street, Some City, California

The project is a 16-story hotel with 2 levels of underground parking, 15,000 square feet per floor. The structural system consists of a special moment resisting steel frame on mat foundation with precast concrete panel exterior cladding. Floors are concrete on metal deck. Shop steel fabrication will start around the first of November. Construction of the core and shell will begin in late April and last for about 14 months.

1. **Inspection** - Lead Inspector
 Approx. ____ days x ____ hrs = ____ hrs at \$ ____ per hr = \$ ____
 Describe what portions of the work the lead inspector will inspect

2. **Concrete**, cast-in-place - ____ cubic yards - approx. ____ pours
 Supplier: Best Ready-Mix, San Francisco
 Review mix designs ____ at \$ ____ each = \$ ____
 Inspection in addition to lead inspector activities:
 Reinforcing steel placement inspection ____ hrs at \$ ____ per hr = \$ ____
 Test specimen transport ____ trips at \$ ____ per trip = \$ ____
 Compression tests ____ cylinders at \$ ____ ea = \$ ____

3. **Precast Concrete** - Prestressed Piles and Precast Panels
 Fabrication Yard: Hardrock, Pleasanton. Hardrock is an approved fabricator for Some City, but periodic inspection is specified by the structural engineer.
 Precast Prestressed Piles - ____ piles, ____ days fabrication
 Precast Concrete Panels - ____ panels - ____ days fabrication
 Concrete Inspection ____ hrs at \$ ____ per hr = \$ ____
 Welding Inspection ____ hrs at \$ ____ per hr = \$ ____
 Describe how your agency proposes to handle periodic precast inspection.

4. **Structural Steel** - ____ tons - ____ months - ____ shift/day
 Fabricator: Major Steel - Nearby, California. Erection schedule - ____ weeks
 Shop Inspection ____ hrs at \$ ____ per hr = \$ ____
 Field Inspection not by lead inspector ____ hrs at \$ ____ per hr = \$ ____

5. **Metal Stairs** - ____ weeks, ____ shifts/day
 Fabricator: Quality Steel, Desert City, Utah
 Shop Inspection ____ hrs at \$ ____ per hr = \$ ____
 Additional Costs (Itemize costs for travel, per diem, etc.) = \$ ____
 Describe how your agency proposes to handle out-of-state inspection and multiple shifts

6. **Fireproofing**, spray-applied - ____ sq ft per floor x ____ floors
 Field Inspection not by lead inspector ____ hrs at \$ ____ per hr = \$ ____
 Density tests ____ tests at \$ ____ each = \$ ____

7. **Smoke-control system** - Periodic inspection of ductwork erection/system testing
 Field Inspection not by lead inspector ____ hrs at \$ ____ per hr = \$ ____
 Describe how your agency will handle this periodic inspection

TOTAL ESTIMATE \$ ____

RESOURCES

- Guidelines for Building Officials - Special Inspection by Licensed Engineers & Architects* - Special Inspection Committee of the Peninsula, East Bay, and Monterey Bay Chapters, International Conference of Building Officials - 1993. c/o Zan Turner, City & County of San Francisco, Dept. Of Building Inspection, 1660 Mission St., San Francisco, CA 94103; 415-558-6104.
- “Guidelines for Issuing Identification Cards for Special Inspectors” from *Guidelines for Special Inspection in Construction* - California Council of Testing & Inspection Agencies - 1996. c/o Cliff Craig, DCI, 415 Fairchild Dr., Mountain View, CA 94043; 650-967-6982.
- Guidelines for the Inspection of High-Strength Bolts* - Structural Engineers Association of Northern California, 74 New Montgomery Street, Suite 230, San Francisco, CA 94105: 415-9745147. Order No. NC #93-4
- Handbook to the Uniform Building Code* - International Conference of Building Officials, Whittier, CA, 1995. ICBO, 5360 S. Workman Mill Rd., Whittier, CA 90601: 800-423-6587.
- Interpretation of Regulations 26-6*, “Expansion Anchors in Hardened Concrete”, in *Structural Safety Interpretive Manual* - Division of the State Architect, Office of Regulation Services, 1300 “I” Street, Suite 800, Sacramento, CA 95814: 916-323-5957
- Model Program for Special Inspection* - International Conference of Building Officials, Whittier, CA, 1991. ICBO, 5360 S. Workman Mill Rd., Whittier, CA 90601: 800-423-6587.
- “Recognition Requirements for Special Inspection Agencies” - Special Inspection Committee of the Peninsula, East Bay, and Monterey Bay Chapters, International Conference of Building Officials - 1996. c/o Zan Turner, City & County of San Francisco, Dept. Of Building Inspection, 1660 Mission St., San Francisco, CA 94103; 415-558-6104.
- Recommended Guidelines for the Practice of Structural Engineering in California*, Structural Engineers Association of California, 555 University Avenue, Suite 126, Sacramento, CA 95825, 916/427-3647.
- “Selecting a Special Inspection Agency - Structural Engineers Association of Northern California, 1997. c/o Structural Engineers Association of Northern California, 74 New Montgomery Street, Ste 230, San Francisco, CA 94105; 415-974-5147
SEAONC "News", February 1998 & March 1998
- Special Inspection Guidelines for Building Departments* - Special Inspection Committee of the Peninsula, East Bay, and Monterey Bay Chapters, International Conference of Building Officials - 1995. c/o Zan Turner, City & County of San Francisco, Dept. Of Building Inspection, 1660 Mission St., San Francisco, CA 94103; 415-558-6104.
- Uniform Building Code* - International Conference of Building Officials, Whittier, CA, 1995. ICBO, 5360 S. Workman Mill Rd., Whittier, CA 90601: 800-423-6587.