



# WPI

## Overview of Qualifications and Building Control During the Design Phase in the USA

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IRCC Workshop: Verification, Documentation and Control of Building Regulations in the Design Phase

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# Background

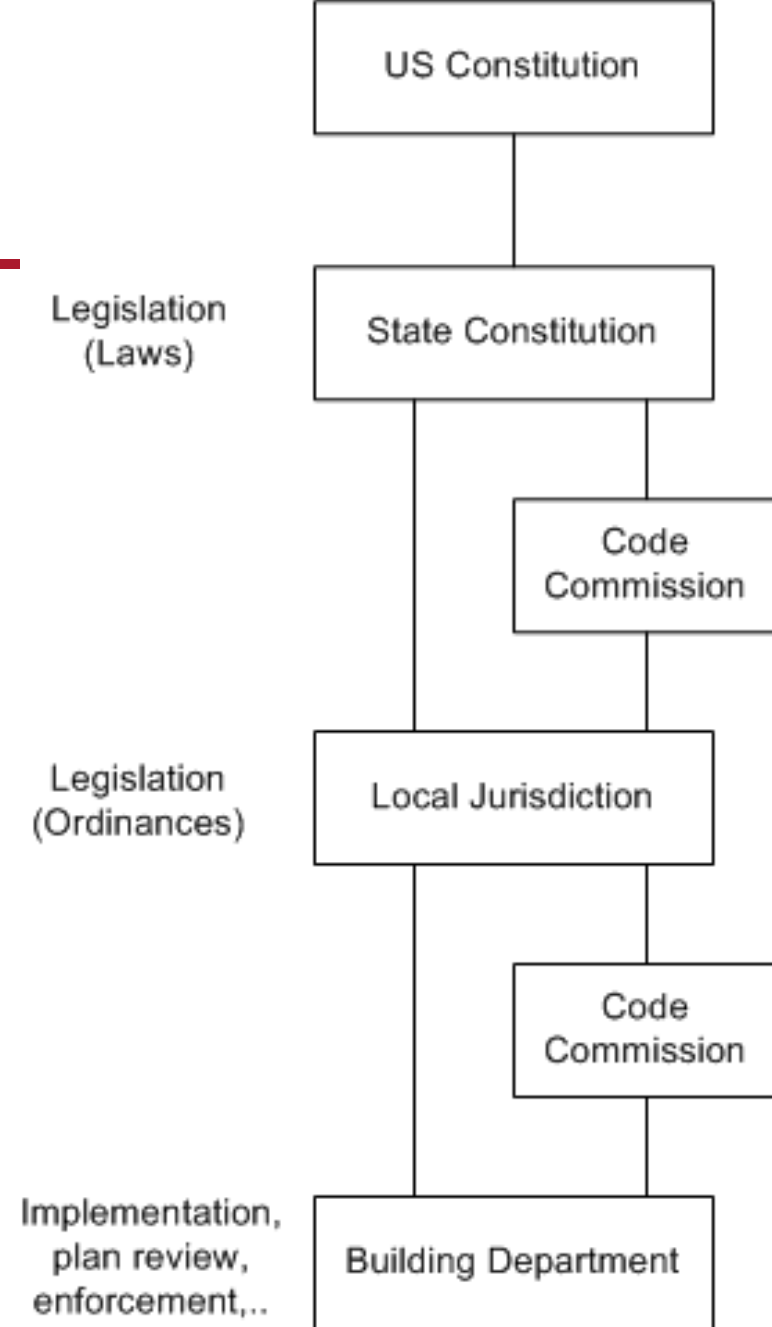
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- Request from Boverket to gain understanding of how verification, documentation and control of building regulations is addressed for mechanical resistance and stability and safety in case of fire during the building design phase
- Discuss in context of 5-story residential structure
- Overview building regulatory system in USA
- Example: New York City
  - Requirements, documentation, qualifications, inspections, ...

# Regulatory Structure

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- No national requirement for building regulation
- No federal government agency responsible for building regulation
- No national building code
- “Model” building codes and standards are developed in the private sector, adopted into legislation at the state or local level, and are enforced locally
- The building code system is largely prescriptive, but includes some performance measures, and permits performance-based design options



# Model Codes for Buildings

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- International Code Council (ICC)
  - International Building Code
  - International Existing Building Code
  - International Energy Conservation Code
  - International Fire Code
  - International Wildland Urban Interface Code
  - International Fuel Gas Code
  - International Mechanical Code
  - ICC Performance Code
  - International Plumbing Code
  - International Property Maintenance/Zoning Code
  - International Residential Code

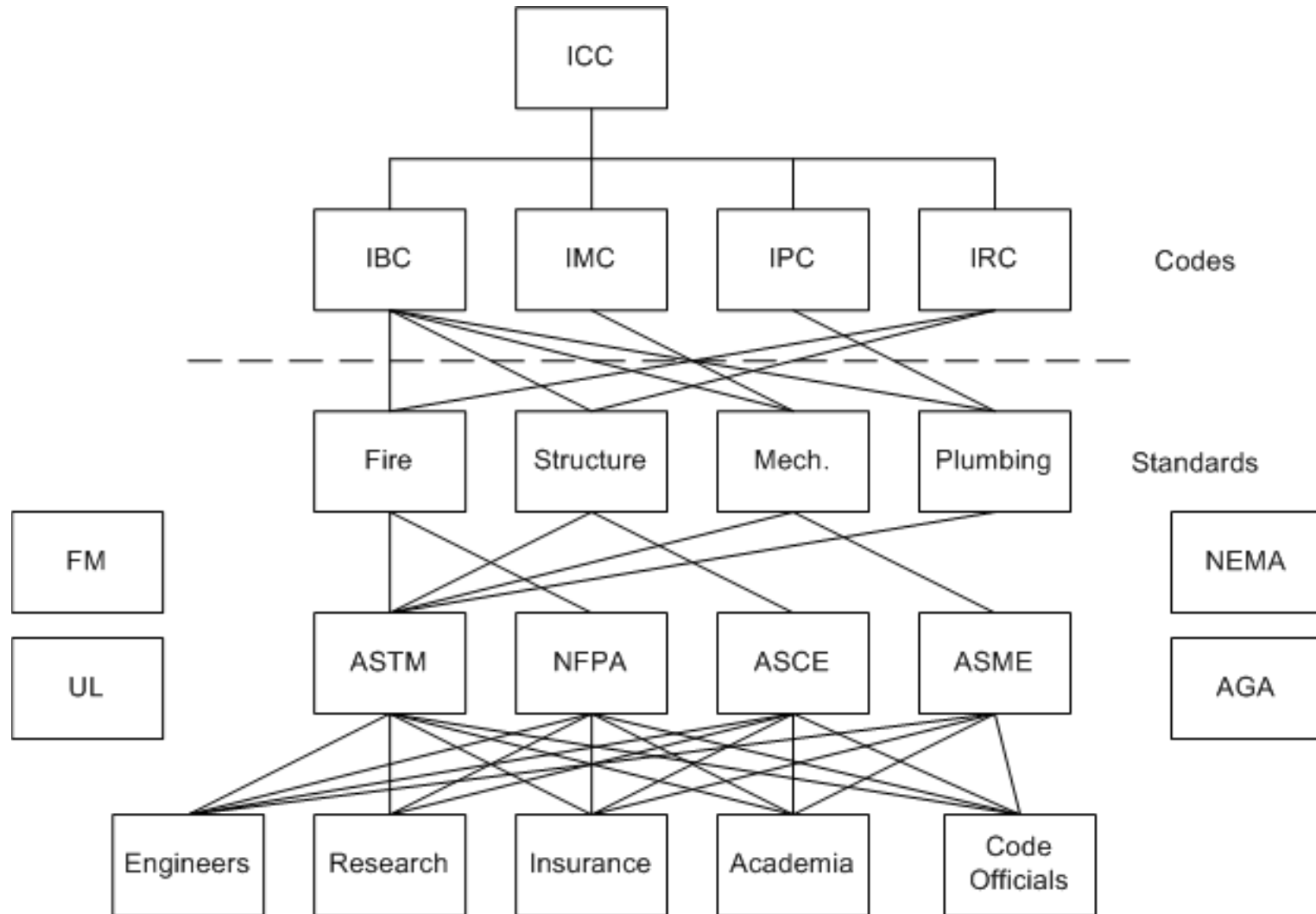


# International Building Code

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- Chapters include
  1. Administration
  3. Use & occupancy (e.g., assembly, residential, ...)
  6. Types of construction (e.g., non-combustible, ...)
  7. Fire resistance
  8. Fire performance of interior finishes
  9. Fire protection systems
  10. Egress systems
  14. Exterior walls
  15. Roof assemblies
  16. Structural design
  17. Structural tests and special inspections
  - 19-26. Materials

# Supporting Standards, Guides, ...



# Control of Building Products

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- Control of building product 'performance' largely a function of standards
  - For example, the IBC might require that a particular structural element have a 1-hr fire resistance rating
  - The test for FRR would be defined by an ASTM standard (American Society for Testing of Materials) and/or NFPA Standard
  - The test would be conducted by a recognized lab, such as Underwriters Laboratories (UL), following a protocol they develop, and they will 'list' the product
  - Checks are then made that listed product is used and installed correctly in a building

# Code Enforcement

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- Varies by jurisdiction – most have plan review and approval by government (building department)
  - Plan and document review is primarily compared to the building code, assuming use of ‘listed’ products (UL label)
  - Most jurisdictions require some level of site inspection and approval before issuing certificate of occupancy
  - Some jurisdictions have special review and inspection requirements (e.g., California has requirement for seismic engineering competency in design, third party review of design, and special inspection)





# Qualifications / Licensing

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- States have authority to regulate professions
  - States have boards for licensing of professional engineers (PE) and architects (RA) – professionals must be licensed by each state where the practice
  - Common requirements: examinations administered by the National Council of Examiners for Engineering and Surveying (NCEES) - <http://ncees.org/>
    - Engineering degree from accredited university plus 4 (or more) years of experience
    - Fundamentals of Engineering Exam
    - Professional Engineering Exam
  - States may require certified building officials (CBO)
    - ICC certifies building officials (grants CBO designation)

# Questions

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- How is it verified that the requirements in the building codes are met? **Checking of design documentation by government.**
- Who verifies that the requirements are met? **Code official.**
- What design documents in terms of drawings, calculations etc. shall be presented to the authorities or other control bodies? **All\***
- When shall the design documents be presented?
  - **Before the construction start?**
  - Continuously during the construction?
- What are the requirements regarding documentation of:
  - Controls by authorities, consultants and project managers? **Varies.**
  - Design calculations? **Varies – often in design documentation.**
  - Building materials used? **Varies – depends on certifications / listing.**
- What qualification should structural designers and fire safety engineers have?
  - Certifications on a national or regional levels or are there no such requirements? **Yes.**
  - What minimum formal education shall they have? **Typically 4-year university.**
- What other requirements do you have regarding verification, documentation and control during the design phase?

# 5-Story Residential Building

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- Assume domestic housing (residential in USA include hotels, hostels, dormitories, etc.), R3
- Assume 5-stories above grade is more than 23 m in elevation, therefore high-rise building
- Assume in NYC, therefore follow NYC Building Code (IBC, 2008, with local modifications)
- Building code compliance under jurisdiction of NYC Department of Buildings
- Professional qualifications under NY State requirements for professional engineers

# NYC Department of Buildings

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- About 975,000 buildings in NYC
- The Department of Building (DoB) has about 1000 staff, of which 200 are inspectors. Annually, DoB:
  - Issues approximately **136,000** new and renewed permits
  - Performs over **412,000** inspections
  - Issues over **16,400** tradesperson's licenses and registrations (25 different types)
  - Answers nearly **400,000** Customer Service Calls
  - Reviews nearly **80,000** construction applications
  - Serves nearly **65,000** violations
  - Issues over **10,000** Stop Work Orders
- <http://www2.iccsafe.org/states/newyorkcity/Building/Building-Frameset.html>

# Verification of Code Requirements

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- Initial responsibility for engineer to conduct code review, design to meet code requirements and prepare construction documents
- Only licensed design professional can apply
  - **§28-104.6 Applicant.** The applicant for approval of construction documents shall be the registered design professional who prepared or supervised the preparation of the construction documents on behalf of the owner.
- Apply for permit
  - **§28-104.1 General.** The department shall not issue a permit pursuant to this code, or a place of assembly operation certificate pursuant to this code unless and until it approves all required construction documents for such work.

# Qualifications / Licensing (NY)

Education/ Experience Credit	12 Years of credit required for admission to the Principles and Practice examination and for licensure											
	ABET-Accredited			Non-ABET Accredited								
12 Years -												
11 Years -												
10 Years -												
9 Years -												
8 Years -												
7 Years -												
6 Years -	6 years of a combination of education and experience credit required for admission to the Fundamentals of Engineering examination											
5 Years -												
4 Years -												
3 Years -												
2 Years -												
1 Year -												
HIGHEST DEGREE	Bachelor	Bachelor	Associate	Bachelor	Bachelor	Bachelor	Bachelor	Associate	Associate	Bachelor	Associate	None
FIELD OF STUDY	Engineering	Engineering Technology	Engineering Technology	Engineering	Technology	Architecture	Science Related to Engineering	Engineering Science/ Pre-Eng. Equivalent	Technology	Not Directly related to Engineering	Not Directly related to Engineering	No College Study
ACCREDITATION	ABET/EAC	ABET/TAC	ABET	Regional	Regional	Regional	Regional	Regional	Regional	Regional	Regional	N/A

Educational credit based in education

Engineering work experience credit needed

# Permits

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- **§28-105.2 Classification of work permits.** For the purposes of this code, work permits shall be classified as follows:
  1. New building permits:
  2. Alteration permits:
  3. Foundation and earthwork permits:
  4. Full demolition permits:
  5. Plumbing permits:
  6. Sign permits:
  7. Service equipment permits:
  8. Temporary construction equipment permits:
  9. Fire suppression system permits:
  10. Crane and derrick permits:

# Required Design Documents

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- **106.2 Required construction documents.** In addition to the requirements of Chapter 1 of Title 28 of the *Administrative Code*, the applicant shall submit any and all of the documents specified in Sections 106.3 through 106.15 as appropriate to the nature and extent of the work proposed.
  - 106.3 Lot diagram.
  - 106.4 Building classification statement.
  - 106.5 Means of egress plans.
  - 106.6 Architectural plans.



# Required Design Documents

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- **106.2 Required construction documents.**
  - 106.7 Structural plans.
    - 106.7.1 Foundation plans.
    - 106.7.2 Floor plans.
    - 106.7.3 Detailed drawings.
    - 106.7.4 Column schedules.
    - 106.7.5 Truss forces.
    - 106.7.6 Pre-stressing forces.
    - 106.8 Excavation and earthwork plans.

# Required Design Documents

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- 106.9 Fire protection system plans.
  - 106.9.1 Sprinkler systems.
  - 106.9.2 Alternative automatic fire-extinguishing systems.
  - 106.9.3 Standpipe systems.
  - 106.9.4 Fire alarm and detection systems.
- 106.10 Sign installation plans.
- 106.11 Sewer adequacy verification.
- 106.12 Pre-demolition photographs.
- 106.13 Energy efficiency.
- 106.14 Mechanical and fuel gas plans.
- 106.15 Plumbing plans.

# Required Design Documents

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- **106.7.1 Foundation plans.** Foundation plans shall show compliance with the requirements of Chapter 18 of this code regarding foundation design and shall show the plan locations, design elevations of the bottoms, and details as to sizes, reinforcements, and construction of all footings, piers, foundation walls, pile groups, and pile caps. The levels of footings of adjacent structures shall be indicated or, if the adjacent structures are pile supported, this shall be stated. Where applicable, the plans shall include underpinning details. In addition, there shall be a statement indicating the character and minimum class of the soil strata required for the support of the foundation; the allowable soil pressure used for the design of footings; and the character, class, and presumptive bearing capacity of the bearing stratum to which piling is required to penetrate. The types and design capacities of piling and the records of required borings or test pits shall also be shown. In addition, foundation plans shall include insulation details as required by the *New York City Energy Conservation Code*.

# Required Design Documents

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- **106.7.2 Floor plans.** Floor plans and sections showing all structural requirements shall be provided for all levels.
- **106.7.3 Detailed drawings.** Drawings shall show sizes, sections, and locations of members, and such other information as may be required to indicate clearly all structural elements and special structural engineering features.
- **106.7.4 Column schedules.** Column schedules shall show the design load contributed by the framing at any level and the total accumulated design load at each level.
- **106.7.5 Truss forces.** Where trusses are employed, a diagram or table shall indicate the loads or moments in the various members under the design loading conditions. The requirement for a diagram or table may be waived when the trusses consist of elements selected from load tables or similar data, subject to the requirements for verification described in this code.
- **106.7.6 Pre-stressing forces.** Where pre-stressed members are employed, a schedule or table shall show the total prestressing forces and the method and sequence of application.

# Required Design Documents

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- Materials
  - **§28-113.1 General.** Materials shall be used, tested and approved for use in accordance with the specific provisions of this code and department rules, except that the commissioner shall have the power to limit or prohibit the use of any material to protect public safety. Materials shall be identified or described on construction documents and other submittal documents.

# Responsibility for Verification

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- **§28-104.2 Application for approval of construction documents.**
  - The department shall assign a job number to and docket all applications for approval of construction documents and any amendments thereto filed with it. **The department shall examine the construction documents promptly after their submission.** The examination shall be made under the direction of the commissioner for compliance with the provisions of this code and other applicable laws and rules. **The personnel employed for the examination of construction documents shall be qualified registered design professionals, experienced in building construction and design.**

# Responsibility for Verification

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- **§28-104.2.5 Phased or partial approval.** In the case of construction documents for the construction of new buildings or the alteration of buildings, the commissioner may grant partial approval of construction documents for the issuance of foundation and earthwork permits before the construction documents for the entire building or structure have been submitted. The approval of such partial applications will be subject to the submittal and approval of construction documents, filed together or separately, comprising:
  1. The lot diagram showing the exact location of the lot and dimensions to the nearest corner;
  2. A complete zoning analysis showing compliance of the proposed work with the zoning resolution;
  3. The foundation plans, as provided for in this code; and
  4. The floor and roof plans showing compliance with exit requirements, as provided for in this code.

# Inspections

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- **109.3 Required progress inspections.** The inspections set forth in Sections 109.3.1 through 109.3.8 shall be made during the progress of work to verify substantial compliance with the code and with approved construction documents.
  - **109.3.1 Footing and foundation inspection.** Footing and foundation inspections shall be made after excavations for footings are complete and any required reinforcing steel is in place. For concrete foundations, any required forms shall be in place prior to inspection. Materials for the foundation shall be on the job, except where concrete is ready mixed in accordance with ASTM C 94, the concrete need not be on the job.
  - **109.3.2 Lowest floor elevation.** In areas of special flood hazard, upon placement of the lowest floor, including the basement (for flood zone purposes), and prior to further vertical construction, the elevation inspection report required in Item 1 of Section G105.3 of Appendix G shall be submitted to the department.
  - **109.3.3 Frame inspection.** Framing inspections shall be performed to determine compliance with the approved construction documents.



# Inspections

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- **109.3.4 Fire-resistance-rated construction inspection.** Fire-resistance-rated construction shall be inspected to determine compliance with the approved construction documents, including inspection of the following work:
  1. Fire-resistance-rated partitions, floors, ceilings, shafts;
  2. Fireblocking of concealed spaces;
  3. Through-penetration firestopping, draftstopping and fireblocking;
  4. Fire dampers;
  5. Fire shutters; and
  6. Protection of structural members.
- **109.3.5 Energy code compliance inspections.** Inspections shall be made to determine compliance with approved construction documents.
- **109.3.6 Other inspections.** In addition to the inspections specified above, the commissioner is authorized to make or require other inspections of any construction work to ascertain compliance with the provisions of this code and other laws that are enforced by the department.

# Inspections

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- **§28-116.2 Types of inspections.** The inspections set forth in sections 28-116.2.1 through 28-116.2.4 are required or authorized by this code.
- **§28-116.2.1 Preliminary inspection.** (existing building)
- **§28-116.2.2 Compliance inspections.**
- **§28-116.2.3 Special inspections and other inspections required during the progress of work.**
  - ... All inspection reports shall be in writing and signed by the person or entity performing the inspection. **A record of all inspections shall be kept by the person performing the inspection.** The commissioner may require inspection reports to be filed with the department. **Records of inspections made by approved agencies and special inspectors shall be maintained by such persons for a period of six years after sign-off of the job or for such other period of time as the commissioner may require and shall be made available to the department upon request.**

# Inspections

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- **§28-116.2.3.1 Special inspection of fabricated items.**
- **§28-116.2.4 Final inspection.** There shall be a final inspection of all permitted work. Final inspections shall comply with sections 28-116.2.4.1 through 28-116.2.4.2.
- **§28-116.2.4.1 Final inspection prior to certificate of occupancy.**
- **§28-116.2.4.2 Final inspection prior to letter of completion.**
- **§28-116.3 Inspection requests.** It shall be the duty of the permit holder to notify the department or the person designated to perform the inspection when work requiring inspection is ready to be inspected. It shall be the duty of the permit holder to provide access to and means for inspection of such work for any inspections that are required by this code.
- **§28-116.4 Sign-off of completed work.**

# Inspections

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- **1604.6 In-situ load tests.** The *building official* is authorized to require an engineering analysis or a load test, or both, of any construction whenever there is reason to question the safety of the construction for the intended occupancy. Engineering analysis and load tests shall be conducted in accordance with IBC Section 1714.
- **1604.7 Preconstruction load tests.** Materials and methods of construction that are not capable of being designed by *approved* engineering analysis or that do not comply with the applicable material design standards listed in Chapter 35, or alternative test procedures in accordance with IBC Section 1712, shall be load tested in accordance with IBC Section 1715.

# Inspections – Steel

VERIFICATION AND INSPECTION		CONT.	PER.	REFERENCED STANDARD <sup>a</sup>	REFERENCE
<b>1.</b>	Material verification of high-strength bolts, nuts and washers:				
a.	Identification markings to conform to ASTM standards specified in the approved construction documents.	-	X	Applicable ASTM material specifications; AISC 360, Section A3.3	-
b.	Manufacturer's certificate of compliance required.	-	X	-	-
<b>2.</b>	Inspection of high-strength bolting:				
a.	Bearing-type connections.	-	X	AISC 360, Section M2.5	1704.3.3
b.	Slip-critical connections.	X	X		
<b>3.</b>	Material verification of structural steel:				
a.	Identification markings to conform to ASTM standards specified in the approved construction documents.	-	-	ASTM A 6 or ASTM A 568	1708.4
b.	Manufacturers' certified mill test reports.	-		ASTM A 6 or ASTM A 568	
<b>4.</b>	Material verification of weld filler materials:				

4. Material verification of weld filler materials:					
a.	Identification markings to conform to AWS specification in the approved construction documents.	-	-	AISC 360, Section A3.5	-
b.	Manufacturer's certificate of compliance required.	-	-	-	-
5. Inspection of welding:					
a.	Structural steel:	-	-		
	1) Complete and partial penetration groove welds.	X	-	AWS D1.1	1704.3.1
	2) Multipass fillet welds.	X	-		
	3) Single-pass fillet welds $> \frac{5}{16}$ "	X	-		
	4) Single-pass fillet welds $\leq \frac{5}{16}$ "	-	X		
	5) Floor and roof deck welds.	-	X	AWS D1.3	-
b.	Reinforcing steel:	-	-		
	1) Verification of weldability of reinforcing steel other than ASTM A 706.	-	X	AWS D1.4 ACI 318: 3.5.2	-
	2) Reinforcing steel-resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special reinforced concrete shear walls and shear reinforcement.	X	-		
	3) Shear reinforcement.	X	-		
	4) Other reinforcing steel.	-	X		
6. Inspection of steel frame joint details for compliance with approved construction documents:					
			X		
a.	Details such as bracing and stiffening.	-	-	-	1704.3.2
b.	Member locations.	-	-		
c.	Application of joint details at each connection.	-	-		

# Inspections - Concrete

<b>VERIFICATION AND INSPECTION</b>	<b>CONTINUOUS</b>	<b>PERIODIC</b>	<b>REFERENCED STANDARD<sup>a</sup></b>	<b>REFERENCE</b>
1. Inspection of reinforcing steel, including prestressing tendons, and placement.	-	X	ACI 318: 3.5, 7.1-7.7	1913.4
2. Inspection of reinforcing steel welding in accordance with Table 1704.3, Item 5b.	-	-	AWS D1.4 ACI 318: 3.5.2	-
3. Inspect bolts to be installed in concrete prior to and during placement of concrete where allowable loads have been increased.	X	-	-	1911.5
4. Verifying use of required design mix.	-	X	ACI 318: Ch. 4, 5.2-5.4	1904.2.2, 1913.2, 1913.3
5. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	-	ASTM C 172 ASTM C 31 ACI 318: 5.6, 5.8	1913.10
6. Inspection of concrete and shotcrete placement for proper application techniques.	X	-	ACI 318: 5.9, 5.10	1913.6, 1913.7, 1913.8
7. Inspection for maintenance of specified curing temperature and techniques.	-	X	ACI 318: 5.11-5.13	1913.9
8. Inspection of prestressed concrete: a. Application of prestressing forces.	X	-	ACI 318: 18.20	-
b. Grouting of bonded prestressing tendons in the seismic-force-resisting system.	X	-	ACI 318: 18.18.4	-
9. Erection of precast concrete members.	-	X	ACI 318: Ch. 16	-
10. Verification of in-situ concrete strength, prior to stressing of tendons in posttensioned concrete and prior to removal of shores and forms from beams and structural slabs.	-	X	ACI 318: 6.2	-

# Inspections - Masonry

INSPECTION TASK	FREQUENCY OF INSPECTION		REFERENCE FOR COMPLIANCE	
	Continuous during task listed	Periodically during task listed	IBC section	ACI 530/ASCE 5/TMS 402 <sup>a</sup>
1. As masonry construction begins, the following shall be verified to ensure compliance:				
a. Proportions of site-prepared mortar.		X	-	-
b. Construction of mortar joints.	-	X	-	-
c. Location of reinforcement, connectors, prestressing tendons and anchorages.		X	-	-
d. Prestressing technique.	-	X	-	-
e. Grade and size of prestressing tendons and anchorages.	-	X	-	-
2. The inspection program shall verify:				
a. Size and location of structural elements.	-	X	-	-
b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.	-	X	-	Sec. 1.2.2(e), 2.1.4, 3.1.6
c. Specified size, grade and type of reinforcement.	-	X	-	Sec. 1.13
d. Welding of reinforcing bars.	X	-	-	Sec. 2.1.10.7.2, 3.3.3.4(b)
e. Protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F).	-	X	Sec. 2104.3, 2104.4	-
f. Application and measurement of prestressing force.	-	X	-	-
3. Prior to grouting, the following shall be verified to ensure compliance:				
a. Grout space is clean.		X		-
b. Placement of reinforcement and connectors and prestressing tendons and anchorages.		X		Sec. 1.13
c. Proportions of site-prepared grout and prestressing grout for bonded		X		



# Qualifications of Inspectors

CATEGORY	CODE REFERENCES	MINIMUM QUALIFICATIONS
Reinforced Concrete	1704.4	<ol style="list-style-type: none"> <li>1. Current ICC Reinforced Concrete Special Inspector or ACI Concrete Construction Inspector.</li> <li>2. Concrete field testing can be by an ACI Concrete Field Testing Technician with Grade 1 certification.</li> <li>3. Engineer-in-Training (EIT) with relevant experience.</li> <li>4. New York State Licensed Professional Engineer (P.E.) with relevant experience.</li> </ol>
Prestressed Concrete	Table 1704.4	<p>Pretension Tendons</p> <ol style="list-style-type: none"> <li>1. Current ICC Reinforced Concrete certification and ICC prestressed concrete certification and ACI Concrete Field Testing Technician with Grade 1 certification plus one year relevant experience.</li> <li>2. EIT with relevant experience.</li> <li>3. P.E. with relevant experience.</li> </ol> <p>Post-tension Tendons</p> <ol style="list-style-type: none"> <li>1. Current Post-Tensioning Institute (PTI) certification.</li> <li>2. EIT with relevant experience.</li> <li>3. P.E. with relevant experience.</li> </ol>

# Qualifications of Inspectors

CATEGORY	CODE REFERENCES	MINIMUM QUALIFICATIONS
Welding	1704.3; Table 1704.3,Item 5; Table 1704.4,Item 2; 1707.2; 2208	<ol style="list-style-type: none"> <li>1. Current AWS Certified Welding Inspector.</li> <li>2. Current ICC Structural Steel and Welding certificate plus one year of relevant experience.</li> <li>3. Current Level II certification from the American Society for Nondestructive Testing (NDT).</li> <li>4. Current NDT Level III provided previously certified as NDT level II.</li> </ol>
High-strength Bolting & Steel Frame Inspection	1704.3.3; Table 1704.3	<ol style="list-style-type: none"> <li>1. Current ICC Structural Steel and Welding certification and one year of relevant experience.</li> <li>2. EIT with relevant experience.</li> <li>3. P.E. with relevant experience.</li> </ol>
Masonry	1704.5; Table 1704.5.1; Table 1704.5.3	<ol style="list-style-type: none"> <li>1. Current ICC Structural Masonry certification and one year of relevant experience.</li> <li>2. EIT with relevant experience.</li> <li>3. P.E. with relevant experience.</li> </ol>
Sprayed Fire-Resistant Materials	1704.11	<ol style="list-style-type: none"> <li>1. Current ICC Spray-Applied Fire Proofing certification and one year of relevant experience.</li> <li>2. EIT with relevant experience.</li> <li>3. P.E. with relevant experience</li> </ol>

# Qualifications of Inspectors

CATEGORY	CODE REFERENCES	MINIMUM QUALIFICATIONS
Excavation and Filling; Verification of Soils; Piling & Drilled Piers; Modular Retaining Walls	1704.7; 704.8; 1704.9; 704.13	<ol style="list-style-type: none"> <li>1. Current Level II certification in geotechnical engineering technology/construction from the National Institute for Certification in Engineering Technologies (NICET).</li> <li>2. EIT with relevant experience.</li> <li>3. P.E. with relevant experience</li> </ol>
Inspection of Fabricators	1704.2	<ol style="list-style-type: none"> <li>1. Precast: Current ICC Reinforced Concrete certification plus one year relevant experience.</li> <li>2. Bar Joist: see welding requirements.</li> <li>3. Metal Building: see welding requirements.</li> <li>4. Structural Steel: see welding requirements.</li> </ol>
Exterior and Interior Architectural Wall Panels	1704.10	<ol style="list-style-type: none"> <li>1. P.E. with relevant experience.</li> <li>2. EIT with relevant experience.</li> <li>3. See the masonry requirements for the SI of masonry veneers subject to BCNYS <a href="#">Section 1704.10</a>.</li> </ol>
Exterior Insulation and Finish System	1704.12	<ol style="list-style-type: none"> <li>1. Registered Design Professional (RDP) with relevant experience.</li> <li>2. EIT with relevant experience.</li> </ol>

# Qualifications of Inspectors

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Smoke Control	1704.14	<ol style="list-style-type: none"> <li>1. See the requirements in BCNYS <a href="#">Section 1704.14.2</a></li> <li>2. The RDP responsible for design.</li> </ol>
Seismic Resistance	1707; 1708	<ol style="list-style-type: none"> <li>1. See the applicable categories in this table.</li> </ol>

# Additional Requirements

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- Some states require additional certification and/or peer review
  - CA requires SE (Structural Engineer) license as higher level than PE, and requires third-party review for seismic designs
  - MA requires third-party review for FSE designs (outside of simple code-based designs)
- Insurance companies may have additional requirements and inspections (e.g., FMGlobal)
- Engineers required professional liability (errors and omissions) insurance

# Alternative Approaches (PBD)

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- 104.11. **An alternative** material, **design** or method of construction shall be approved where the building official finds that the proposed design is satisfactory and **complies with the intent of the provisions of the code**, and that the material, method or work offered is, for the purpose intended, **at least equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.**

# General Approach

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- Identify requirements by code / jurisdiction
- Define scope of alternative design
- Develop analysis, following guidelines, using acceptable data, tools and methods
- Submit analysis and documentation, along with request for approval of alternative design
- Code official may require
  - Specific testing, copies of computational analysis, third party review of all or parts of analysis and reports, additional analysis to be conducted
- Must be developed by licensed design professional

# Alternative Materials

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- Starting point is use of 'listed' products (UL label) and compliance with approved test standards (ASCE, ASTM, NFPA, UL, ...)
- Some alternate paths are identified in code
  - Flame spread and smoke production of interior finishes
  - IBC requires compliance with ASTM E84, or,
  - Compliance with NFPA 286, room corner test, using stated criteria (IBC 803.1.2, 803.1.2.1)



# Alternative Materials & Criteria

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- Testing and reports by approved agencies are readily accepted.
  - Certification via ISO/IEC 17025 or other
- ICC Evaluation Service (ICC-ES)
  - Materials and criteria reports
    - [http://www.oshpd.ca.gov/boards/hbsb/meetings/20110928-meeting/ICC-ES\\_AC156.pdf](http://www.oshpd.ca.gov/boards/hbsb/meetings/20110928-meeting/ICC-ES_AC156.pdf)
    - [http://www.icc-es.org/reports/pdf\\_files/ICC-ES/ESR-3043.pdf](http://www.icc-es.org/reports/pdf_files/ICC-ES/ESR-3043.pdf)

# Alternative Design

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- Engineering analysis and computational modeling, in a performance-based approach, can be accepted as alternative design approach
  - Often used in seismic engineering and fire protection engineering
  - Many of the procedures previously identified apply
  - In addition, numerous guidelines for engineers and code officials
  - Must be undertaken by licensed design professional
    - One can get a Professional Engineers license in Fire Protection Engineering
    - Licensing by state, but nationally consistent exam

# Processes

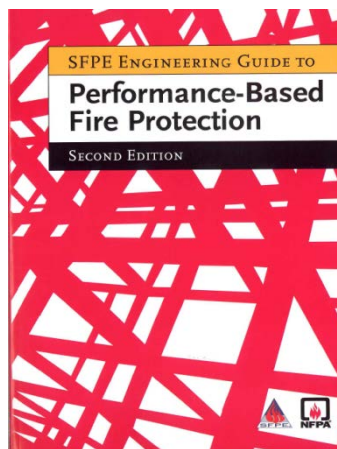
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- Requirements for alternative designs
  - Some jurisdictions mandate process and requirements
    - [http://www.ci.berkeley.ca.us/uploadedFiles/Online\\_Service\\_Center/Planning/Guidelines%20for%20Completing%20Alternative%20Methods%20and%20Materials%20Form%20May102012.pdf](http://www.ci.berkeley.ca.us/uploadedFiles/Online_Service_Center/Planning/Guidelines%20for%20Completing%20Alternative%20Methods%20and%20Materials%20Form%20May102012.pdf)
  - Other jurisdictions leave decisions to code official on case-by-case basis
  - Typically requires considerable documentation

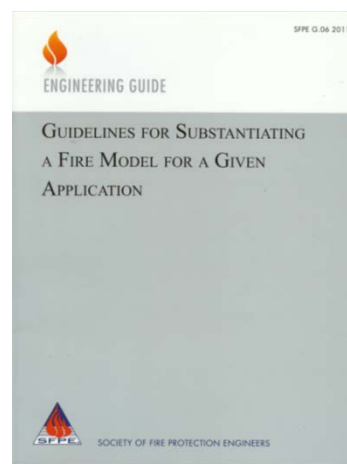
# Alternative Fire Design

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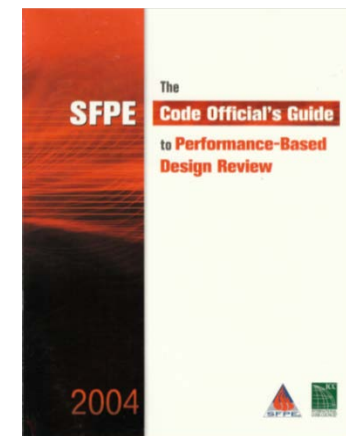
- Various guidelines
  - SFPE Engineering Guide to Performance-Based Fire Protection Design
  - SFPE Engineering Guidelines for Substantiating a Fire Model for a Given Application
  - ICC/SFPE Code Official's Guide to Performance-Based Design Review



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# Paths to Approval

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- There are several paths to approval dependent upon jurisdiction and discipline
  - Approval by code official
    - Alone (suitably qualified)
    - Based on peer review (with concurrence of authority)
  - Approval by third party
    - Designated review body (contracted by government)
    - Designated peer reviewer (identified by jurisdiction, paid by entity seeking alternative design)
  - Approval by review/appeals board

# Summary

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- Complex building regulatory system
- Highly prescriptive, but allows FSE and other engineering from first principles
- Generally very well controlled
  - Licensed design professionals (university / examination)
  - Significant documentation requirements
  - Engineering review, typically by engineers
  - Inspections throughout and at end, before certificate of occupancy
  - Requirements for insurance and other controls
- Can also undertake PBD – even more control!

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**Thank you for your attention!**

**Questions?**

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