Building Commissioning: CALGreen and The Energy Code

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Efficiency Division
California Energy Commission

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California Energy Commission
Background

• Section 25402 of the Public Resources Code (the Warren-Alquist Act)

• The Act created the Energy Commission in 1974 and gave it authority to develop and maintain the Building Energy Efficiency Standards (Standards)

• Requires the Standards and new regulations to be cost effective over the economic life of the structure

• Requires the Commission to update the Standards periodically (about every three years)
2016 Building Energy Efficiency Standards

• Effective on January 1, 2017
  – Building permit applications submitted on or after this date

• Larger projects in plan review may be affected:
  – Need to resubmit if permits pulled on/after effective date
2016 Documents

- Building Energy Efficiency Standards
- Nonresidential Compliance Manual
- Reference Appendices
- All documents are available at: www.energy.ca.gov/title24
Changes in the 2016 Standards for Nonresidential Buildings

Nonresidential measures aligned with ASHRAE National Standards:

• Equipment Efficiencies
• Envelope U-Factors
• Indoor Lighting
• Outdoor Lighting
• Elevators and Escalators
• Direct Digital Controls
• Windows and Doors HVAC Lockout Sensors
What the Future Holds

• AB 32 - Reduce carbon footprint

• CPUC/Energy Commission Strategic Plan:
  – Zero Net Energy use for nonresidential buildings by 2030

• Standards will evolve/expand and become more stringent to reach these goals
2016 Title 24, Part 6 Cx Triggers

All newly constructed nonresidential buildings >10,000 ft\(^2\) trigger all Cx requirements:

- Mixed occupancy portions of high-rise residential or hotel/motel buildings
- All mandatory, prescriptive and performance features covered under Part 6 for conditioned spaces
- Does not include additions and alterations EXCEPT covered process (§120.6 and §140.9)

For buildings <10,000 ft\(^2\):

- Design Review (§ 120.8(d))
- Commissioning measures shown in the construction documents (§ 120.8(e))
What’s The Difference?

• Title 24, Part 11
  – Renewable Energy Systems
  – Landscape Irrigation Systems
  – Water Reuse Systems
  – Covered Process

• Title 24, Part 6
  All building systems and components
  §110.0, 120.0, 130.0 and 140.0
  (excluding covered process)
  – Envelope
  – Ventilation, Space-Conditioning, and Controls
  – Water Heating and Controls
  – Lighting and Controls
  – Solar Ready
  – Electrical Power Distribution
Requirements

New Nonresidential Buildings CFA <10,000 ft²:
- Cx Specifications, NRCC-CXR and NRCA (ATT) requirements only

New Nonresidential Buildings CFA >10,000 ft²: All aspects of Cx required

New Mixed Use Buildings: Required for the CFA associated with NR occupancy

See above for commissioning requirements based on CFA
(not including multifamily; hotel/motel; covered process CFA)

Multifamily/Hotel & Motel/Covered Process: N/A

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**1.** Project Engineer, CxA, owner & project team:
- Draft OPR & BOD documents
- Hold Cx kickoff meeting
- Complete preliminary design review
- Include Cx requirements in plans/specs

**2.** Plan Reviewer:
- Confirms acceptance tests are identified in the construction documents & assigned to responsible parties
- Reviews NRCC-CXR forms that document the design kick-off meeting & Cx design review

**3.** Plan Reviewer:
- Confirms acceptance tests are identified in the construction documents & assigned to responsible parties
- Reviews NRCC-CXR forms that document the design kick-off meeting & Cx design review

**4.** Contractor, or other responsible party:
- Includes testing in the project budget & schedule
- Coordinates CxA, subcontractors & ATT during construction
- Finalizes the Cx Plan

**5.** Contractor, subcontractors, CxA and ATT:
- Prepare for tests by:
  - Reviewing test objectives & procedures
  - Gathering the correct forms & equipment

**6.** Skilled technician:
- Performs functional testing (including acceptance testing performed by ATT)
  - CxA or other responsible party:
  - Observes the testing

**7.** Plan Reviewer:
- Confirms acceptance tests are identified in the construction documents & assigned to responsible parties
- Reviews NRCC-CXR forms that document the design kick-off meeting & Cx design review

**8.** Skilled technician and/or responsible party:
- Completes, reviews and signs applicable NRCA forms in preparation for Building Inspector

**9.** Building Inspector:
- Reviews NRCA forms and determines building complies with applicable codes & standards before final permit is issued

**10.** Occupancy:
- CxA:
  - Conducts Operations and Maintenance training
  - Finalizes Cx Report and gives to owner

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**LEGEND**
- ATT: Acceptance Test Technician
- CFA: Conditioned Floor Area
- Cx: Commissioning
- CxA: Commissioning Authority
- NR: Nonresidential
- NRCA/NRCC: Title 24 Part 6
- Compliance forms
Construction Timeline
Construction Timeline

Commissioning Requirements (Section 120.8)
- Owner Project Requirements
- Basis of Design
Construction Timeline

What is an OPR and a BOD?

**Owner’s Project Requirements (OPR)**
The Owner’s Project Requirements documents the functional requirements of a project and expectations of the building use and operation as it relates to systems being commissioned.

**Basis of Design (BOD)**
The Basis of Design describes the building systems to be commissioned and outlines design assumptions not indicated in the design documents. The design team develops the BOD to describe how the building systems design meets the OPR, and why the systems were selected.

Construction Timeline

The OPR at a minimum includes:

A. *Energy Efficiency Goals* - Establish goals and targets affecting energy efficiency

B. *Ventilation Requirements* - Describe indoor ventilation requirements including intended use and anticipated schedule for each program space

C. *Project Program* - Describe primary purpose, program, and use of proposed project

D. *Equipment and Systems Expectations* - For each system commissioned

E. *Building Envelope Performance Expectations* - For each assembly that contains a special feature

Construction Timeline

The BOD, at a minimum, includes:
Each section below must provide narrative description of system, the reasons for system selection, the design criteria, and how the system meets the OPR, as well as:

A. HVAC Systems and Controls - the sequence of operations
B. Indoor Lighting System and Controls - the lighting power design targets for each type of space
C. Water Heating Systems and Controls - the water heating load calculations
D. Building Envelope Components - nothing additional

Construction Timeline

- Certificate of Compliance (Section 10-103(a)1)
- Design Review (Section 120.8(d))
- Commissioning Measures (Section 120.8(e))
- Commissioning Plan (Section 120.8(f))
- All Required Certificates of Compliance (NRCC) Forms
Construction Timeline

Design Review, Commissioning Measures, Commissioning Plan…are these real things?

**Design Phase Review**
The intent of design phase review is to improve compliance with the Energy Standards, encourage adoption of best practices in design, and lead to designs that are constructible and maintainable.

**Commissioning Measures**
Include commissioning measures or requirements in the construction documents (plans and specifications).

**Commissioning Plan**
The Commissioning Plan establishes the commissioning process guidelines for the project and commissioning team’s level of effort.

Design Phase Review (Section 120.8(d))

Design reviewer requirements are based on the project size and complexity of the mechanical systems.

A. For buildings less than 10,000 square feet, design phase review may be completed by the design engineer.

B. For buildings between 10,000 and 50,000 square feet, it may be completed by either an in-house engineer from the design firm but not associated with the building project, or a third party design engineer.

C. For newly constructed buildings larger than 50,000 square feet or buildings with complex mechanical systems, an independent review by a third party design engineer is required.
Design Phase Review (Section 120.8(d))

A. Design Review Kickoff - Initial Schematic Review
An in-person meeting is held between the project owner, design team representatives, commissioning coordinator, and Design Reviewer.

B. Construction Document Review
The design team provides the design reviewer with a set of drawing plans; typically around 90 percent of construction documents are completed.

The Design reviewer provides a review of the construction documents and completes the necessary Certificate of Compliance forms related to Commissioning.

Commissioning Measures (Section 120.8(e))

The commissioning specifications should include:

• A list of the systems and assemblies covered by the commissioning requirements
• Roles and responsibilities of all parties
• Commissioning schedule management procedures
• Requirements for execution and documentation of installation, checkout, and start up, including control point-to-point checks and calibrations
• Specific testing requirements by system
• Content, authority, and approval process of the commissioning plan
• Facility staff training requirements and verification procedures
• Operation and Maintenance manual review and approval procedures
• System’s manual development and approval requirements and procedures

Construction Timeline

Commissioning Plan (Section 120.8(f))

To include and expand upon all the following elements:

A. General project information
B. Commissioning Goals - Code Compliance, OPR, and BOD requirements, Plans and Specification Requirements
C. Systems to be commissioned - Consistent with the BOD
D. Commissioning Team Information
E. Commissioning process activities, schedules, and responsibilities

Construction Timeline

Application for Building Permit (Section 10-103(a)2)
- All Required NRCC forms
# Construction Timeline

Quick look at the required documents so far:

<table>
<thead>
<tr>
<th>Certificates of Compliance (Commissioning)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Review Kick Off</td>
</tr>
<tr>
<td>NRCC-CXR-01-E</td>
</tr>
</tbody>
</table>

**Sections A-H**
- A - General Information (Climate Zone, Building Type, etc.)
- B - Date of the Kick Off Meeting
- C - Design Review Check Lists
- D - Design Review Qualifications
- E - Meeting Attendees
- F - Documents Received (BOD, Project Requirements, Designs, Specifications)
- G - Design Review Meeting Topics
- H - Coordination Dates (Document Review and Permit Submission)
Construction Timeline

Quick look at the required documents so far:

**Commissioning Compliance Documents**

- Design Review Kick Off
  - NRCC-CXR-01-E
- Construction Documents - General
  - NRCC-CXR-02-E

**Sections A and B**

- A - General Information
- B - Design Review Checklist
  - (Envelope, Lighting, Hot Water, HVAC)
Construction Timeline

Quick look at the required documents so far:

**Commissioning Compliance Documents**

- Design Review Kick Off
  - NRCC-CXR-01-E
- Construction Documents - General
  - NRCC-CXR-02-E

And either of these

**Construction Documents:**

<table>
<thead>
<tr>
<th>Simple HVAC</th>
<th>Complex HVAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRCC-CXR-03-E</td>
<td>NRCC-CXR-04-E</td>
</tr>
</tbody>
</table>

Simple HVAC - Sections A and B

A - General Information

B - Design Review Check List
   (Fan Systems and Controls)
# Construction Timeline

Quick look at the required documents so far:

<table>
<thead>
<tr>
<th>Commissioning Compliance Documents</th>
<th>Complex HVAC - Sections A and B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Review Kick Off</td>
<td>A - General Information</td>
</tr>
<tr>
<td>NRCC-CXR-01-E</td>
<td>B - Design Review Check List</td>
</tr>
<tr>
<td>Construction Documents - General</td>
<td>Fan Systems</td>
</tr>
<tr>
<td>NRCC-CXR-02-E</td>
<td>Supply Air Temperature Reset</td>
</tr>
<tr>
<td>And either of these</td>
<td>Heat Rejection Equipment</td>
</tr>
<tr>
<td>Construction Documents:</td>
<td>Chillers and Boilers</td>
</tr>
<tr>
<td>Simple HVAC</td>
<td>Hydronic Systems - Plumbing</td>
</tr>
<tr>
<td>NRCC-CXR-03-E</td>
<td>Hydronic Heat Pump</td>
</tr>
<tr>
<td>Complex HVAC</td>
<td></td>
</tr>
<tr>
<td>NRCC-CXR-04-E</td>
<td></td>
</tr>
</tbody>
</table>
Construction Timeline

Quick look at the required documents so far:

**Commissioning Compliance Documents**

Design Review Kick Off  
NRCC-CXR-01-E

Construction Documents - General  
NRCC-CXR-02-E

And either of these  
**Construction Documents:**

Simple HVAC  
NRCC-CXR-03-E

Complex HVAC  
NRCC-CXR-04-E

Design Review Signature Page  
NRCC-CXR-05-E

**Sections A-C**

A - General Information
B - Date of Design Review Kick Off
C - Date of Construction Document Check List
Construction Timeline

Quick look at the required documents so far:

**Commissioning Compliance Documents**
- Design Review Kick Off  
  NRCC-CXR-01-E
- Construction Documents - General  
  NRCC-CXR-02-E
- Design Review Signature Page  
  NRCC-CXR-05-E

And either of these **Construction Documents:**
- Simple HVAC  
  NRCC-CXR-03-E
- Complex HVAC  
  NRCC-CXR-04-E

**Certificates of Compliance**
- Electrical Power Distribution  
  NRCC-ELC-01-E
- Envelope (walls, ceiling, roof, windows, doors)  
  NRCC-ENV-01-E to 06-E
- Indoor Lighting  
  NRCC-LTI-01-E to 05-E
- Outdoor Lighting  
  NRCC-LTO-01-E to 03-E
- Sign Lighting  
  NRCC-LTS-01-E
- Mechanical Systems  
  NRCC-MCH-01-E to 07-E
- Plumbing  
  NRCC-PLB-01-E
- Covered Process  
  NRCC-PRC-01-E to 13-E
- Solar Ready & Water Heating  
  NRCC-SRA-01-E to 02-E  
  NRCC-SRH-01-E
## Construction Timeline

### Quick look at the required documents so far:

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Approval Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPR &amp; BOD</td>
<td>Approved by the AHJ at their discretion</td>
</tr>
<tr>
<td>Design Review</td>
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<td>Certificates of Compliance</td>
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</tbody>
</table>
Construction Timeline

OPR
BOD
App
Comp

Permit Issued
Construction Timeline

Certificate of Installation (Section 10-103(a)3)
- All Required NRCI forms
## Construction Timeline

Quick look at the required forms so far:

<table>
<thead>
<tr>
<th>Certificates of Installation</th>
<th>Not Required for commissioning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Power Distribution</strong></td>
<td><strong>Mechanical Systems</strong></td>
</tr>
<tr>
<td>NRCI-ELC-01-E</td>
<td>NRCI-MCH-01-E</td>
</tr>
<tr>
<td><strong>Envelope</strong></td>
<td><strong>Plumbing</strong></td>
</tr>
<tr>
<td>NRCI-ENV-01-E</td>
<td>NRCI-PLB-01-E to 03-E</td>
</tr>
<tr>
<td><strong>Indoor Lighting</strong></td>
<td><strong>Solar Photovoltaic &amp; Water Heating</strong></td>
</tr>
<tr>
<td>NRCI-LTI-01-E to 06-E</td>
<td>NRCI-SPV-01-E</td>
</tr>
<tr>
<td><strong>Outdoor Lighting</strong></td>
<td></td>
</tr>
<tr>
<td>NRCI-LTO-01-E to 02-E</td>
<td>NRCI-SPV-01-E</td>
</tr>
<tr>
<td><strong>Sign Lighting</strong></td>
<td></td>
</tr>
<tr>
<td>NRCI-LTS-01-E</td>
<td>NRCI-STH-01-E</td>
</tr>
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</table>

### Covered Process
- NRCI-PRC-01-E

**Not Required**
Construction Timeline

Certificate of Acceptance (Section 10-103(a)4)
- All Required Acceptance Tests NRCA Forms
- ATTCP Regulations Lighting Controls and Mechanical Systems NRCA Forms
Construction Timeline

Quick look at the required forms so far:

<table>
<thead>
<tr>
<th>Certificates of Acceptance</th>
<th>Mechanical Systems</th>
<th>Covered Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope (Fenestration) NRCA-ENV-02-F</td>
<td>NRCA-MCH-01-A to 17-A</td>
<td>NRCA-PRC-01-F to 08-F</td>
</tr>
<tr>
<td>Indoor Lighting (Certified ATT Req) NRCA-LTI-02-A to 05-A</td>
<td>NRCA-MCH-04-H (duct testing)</td>
<td>NRCA-PRC-12-F (Elevator)</td>
</tr>
<tr>
<td>Outdoor Lighting (Certified ATT Req) NRCA-LTO-02-A</td>
<td></td>
<td>NRCA-PRC-13-F (Escalator)</td>
</tr>
</tbody>
</table>

Not Required
Certificate of Verification (Section 10-103(a)5)

- Home Energy Rating System:
  - Duct Leakage
  - DHW Distribution
Construction Timeline

Quick look at the required forms so far:

Certificates of Verification
Certified HERS Rater Required

Mechanical (Duct testing)
  NRCV-MCH-04(a, c, d, & e)

Plumbing (efficient design verification)
  NRCV-PLB-21-HERS
  NRCV-PLB-22-HERS
Construction Timeline

OPR
BOD

App

Inst

Verif

Comp

Permit Issued

Acpt

Final Inspections
Construction Timeline

- OPR
- BOD
- App
- Inst
- Verif
- Certificate of Occupancy Issued
- Comp
- Permit Issued
- Acpt
- Final Inspections
# Construction Timeline

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Construction Timeline

Commissioning Documentation and Training (Section 120.8(h))
System manuals and systems operations training
Commissioning Report (Section 120.8(i))
A complete report of processes and activities for the building owner
Construction Timeline

What is in the Documentation & Training Report and the Commissioning Report?

**Documentation and Training Report (Section 120.8(h))**
Provides information needed to understand, operate, and maintain the equipment and systems and informs those not involved in the design and construction of the building systems.

**Commissioning Report (Section 120.8(i))**
Documents the commissioning process and test results. The report includes confirmation from the commissioning coordinator verifying that commissioned systems meet the conditions of the OPR, BOD, and Contract Documents.

Construction Timeline

Documentation (Section 120.8(h)1)

A. Site information, including facility description, history, and current requirements
B. Site contact information
C. Basic operation and maintenance, including general site operating procedures, basic trouble shooting, recommended maintenance requirements site events log
D. Major systems
E. Site equipment inventory and maintenance notes
F. A copy of all special inspection verifications required by the enforcing agency of this code
G. Other resources and documentation

Construction Timeline

Training (Section 120.8(h)2)

- The written training program includes:
  - Learning goals and objectives for each session
  - Training agenda, topics, and length of instruction for each session
  - Instructor information and qualifications
  - Location of training sessions (onsite, off-site, manufacturer’s or vendor’s facility)
  - Attendance forms
  - Training materials
  - Description on how the training will be archived for future use

Construction Timeline

Commissioning Report (Section 120.8(i))

- Executive Summary of process and results of commissioning program – including observations, conclusions and any outstanding items
- History of any system deficiencies and resolutions:
  - Include outstanding deficiencies and plans for resolution
  - Include plans for seasonal testing scheduled for a later date
- System performance test results and evaluations
- Summary of training process completed and scheduled
- Attach commissioning process documents

# Construction Timeline

A final look at the required documents:

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Local AHJs are enforcing the Lighting Controls Acceptance Test requirement to use only Certified Acceptance Test Technicians.
Acceptance Test Technician Certification Provider
2016 Title 24, Part 1, Section 10-103.1 and 10-103.2

Train, certify, and oversee technicians to perform acceptance tests required by the Building Energy Efficiency Standards

**Lighting Controls**
- Standards Section 130.4(a)
- NA7.6 through NA7.9 of the Nonresidential Appendix

**Mechanical**
- Standards Section 120.5
- NA7.5.1 through NA7.5.16 of the Nonresidential Appendix
Acceptance Test Technician Certification Provider
2016 Title 24, Part 1, Section 10-103.1 and 10-103.2

Lighting Controls ATTCP:
• California Advanced Lighting Controls Training Program (CALCTP)
• National Lighting Contractors Association of America (NLCAA)

Mechanical ATTCP:
• National Energy Management Institute Committee (NEMIC)
• National Environmental Balancing Bureau (NEBB)
• California State Pipe Trades Council (CSPTC)
Acceptance Test Technician Certification Provider
2016 Title 24, Part 1, Section 10-103.1 and 10-103.2

Lighting Controls ATTCP:
• Threshold Requirements have been met (Section 10-103.1(b))
• Only Certified ATTs can perform Lighting Controls Acceptance Testing

Mechanical ATTCP:
• Threshold Requirements have NOT been met (Section 10-103.2(b))
• Any technician can perform Mechanical Acceptance Testing
ATTCP E-Forms are not the Nonresidential Data Registry

ATTCP - Electronic Forms

- Lighting Controls
- Mechanical Systems

Nonresidential Data Registry

- Commissioning
- Electrical
- Envelope
- Lighting (Indoor, Outdoor, Sign)
- Solar (Solar Ready, PV, Thermal Heating)

- Mechanical
- Covered Process
- Plumbing

- Certificate of Compliance
- Certificate of Installation
- Certificate of Acceptance
- Certificate of Verification
ATTCP E-Forms are not the Nonresidential Data Registry

ATTCP - Electronic Forms

- Certificate of Compliance
- Certificate of Installation
- Certificate of Acceptance
- Certificate of Verification

Nonresidential Data Registry

- Commissioning
- Electrical
- Envelope
- Lighting (Indoor, Outdoor, Sign)
- Solar (Solar Ready, PV, Thermal Heating)

- Mechanical
- Covered Process

5 Forms
17+ Forms
97+ Forms
Differences Between ATTCP and HERS Programs

• Acceptance testing is performed by the installing technicians:
  – Certification is required for Lighting Controls
  – Certification is not required for Mechanical - YET
  – The Acceptance Test Technician is not required to be independent of the general contractor or third-party to the installing technician

• Acceptance test forms are not “registered” with the ATTCP, but they are “recorded” by the ATTCP:
  – HERS Providers are required to register forms under the Standards, Reference Joint Appendix JA7
  – ATTCP typically require certified technicians to record acceptance tests and related compliance documents with their on-line systems
Who is Allowed to be Certified to Perform Acceptance Testing?

• Nonresidential Contractors are not the only professionals allowed to certified to perform acceptance testing.

• The Acceptance Test Technician can be:
  – The General Contractor
  – The Engineer of Record
  – The Architect of Record
  – A Certified Commissioning Professional
  – A Professional Engineer
  – A TAB Certified Technician
  – The Control Installation and Startup Contractor
Resources

- California Energy Commission Efficiency Division’s Educational Resources Webpage: [http://www.energy.ca.gov/efficiency/educational_resources.html](http://www.energy.ca.gov/efficiency/educational_resources.html)
- ListServ (Efficiency, Building Standards, Blueprint): [http://www.energy.ca.gov/efficiency/listservers.html](http://www.energy.ca.gov/efficiency/listservers.html)
- Energy Design Resources Website: [http://energydesignresources.com/](http://energydesignresources.com/)
Public Participation in the Energy Efficiency Standards Update

• Energy Commission web site dedicated to the 2019 Update proceedings: http://www.energy.ca.gov/title24/participation.html

• Sign-up on the Building Standards list serve to be informed of ongoing activities.

• The Public Adviser's Office is available to assist the public with participation in Energy Commission proceedings.
Questions?