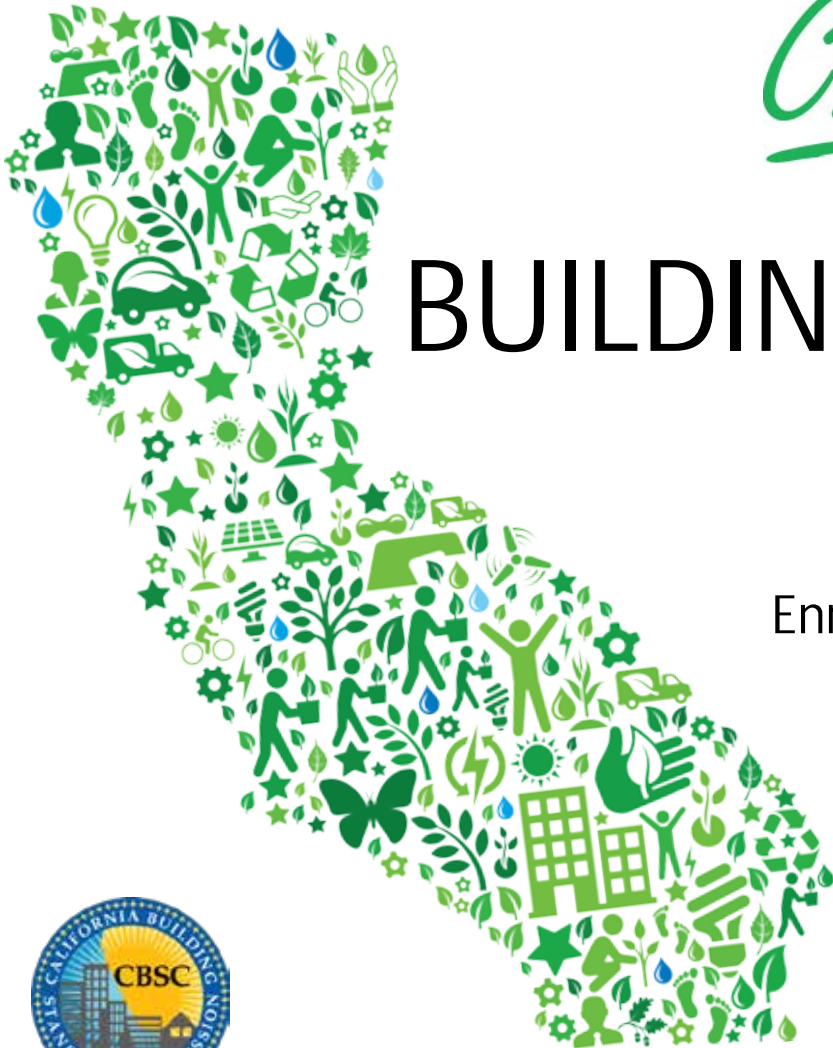




# BUILDING COMMISSIONING

Michael L. Nearman, Deputy Executive Director  
Enrique Rodriguez, Associate Construction Analyst  
California Building Standards Commission

Joe Loyer, Senior Mechanical Engineer  
California Energy Commission



# Building Commissioning: CALGreen and The Energy Code

**Joe Loyer**

**Senior Mechanical Engineer**

**Efficiency Division**

**California Energy Commission**

**California Green Summit**

**Sacramento, CA**

**April 21, 2016**



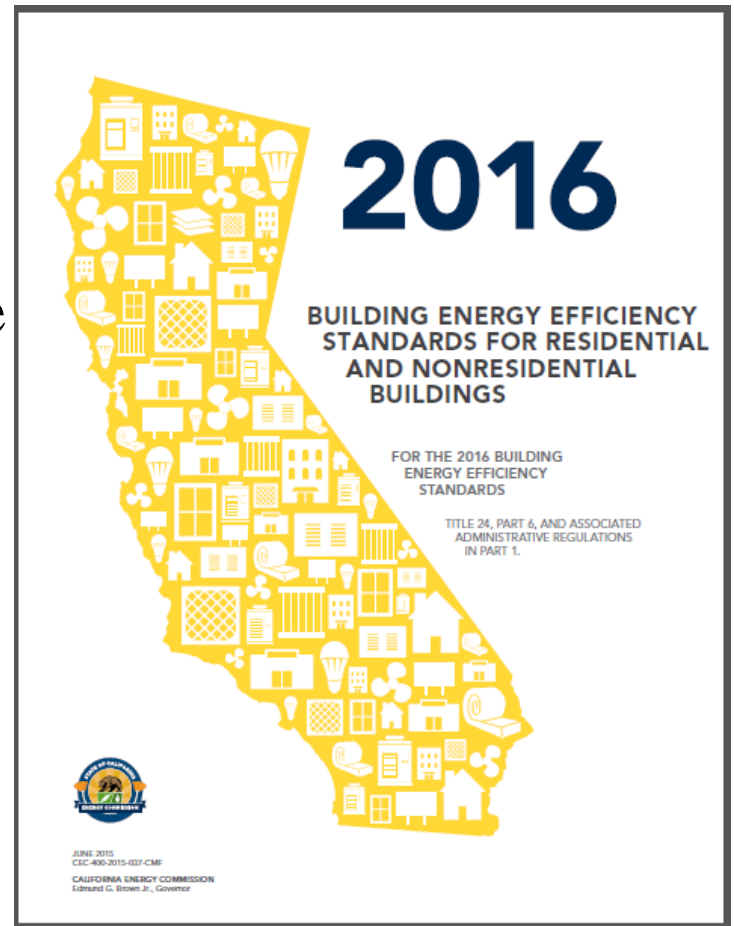
# California Energy Commission Background

- 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](http://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 residential buildings by 2020.
  - Zero Net Energy use for nonresidential buildings by 2030
- Standards will evolve/expand and become more stringent to reach these goals



# 2013 Title 24, Part 6 Cx Triggers

All **newly constructed** nonresidential buildings  $\geq 10,000$  ft<sup>2</sup> 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)*

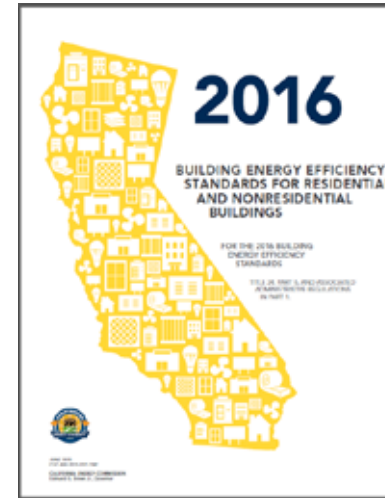
For buildings  $< 10,000$  ft<sup>2</sup> :

- **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 ft<sup>2</sup>:

Cx Specifications, NRCC-CXR and NRCA (ATT) requirements only

### New Nonresidential Buildings CFA >10,000 ft<sup>2</sup>: 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

#### LEGEND

ATT: Acceptance Test Technician

CFA: Conditioned Floor Area

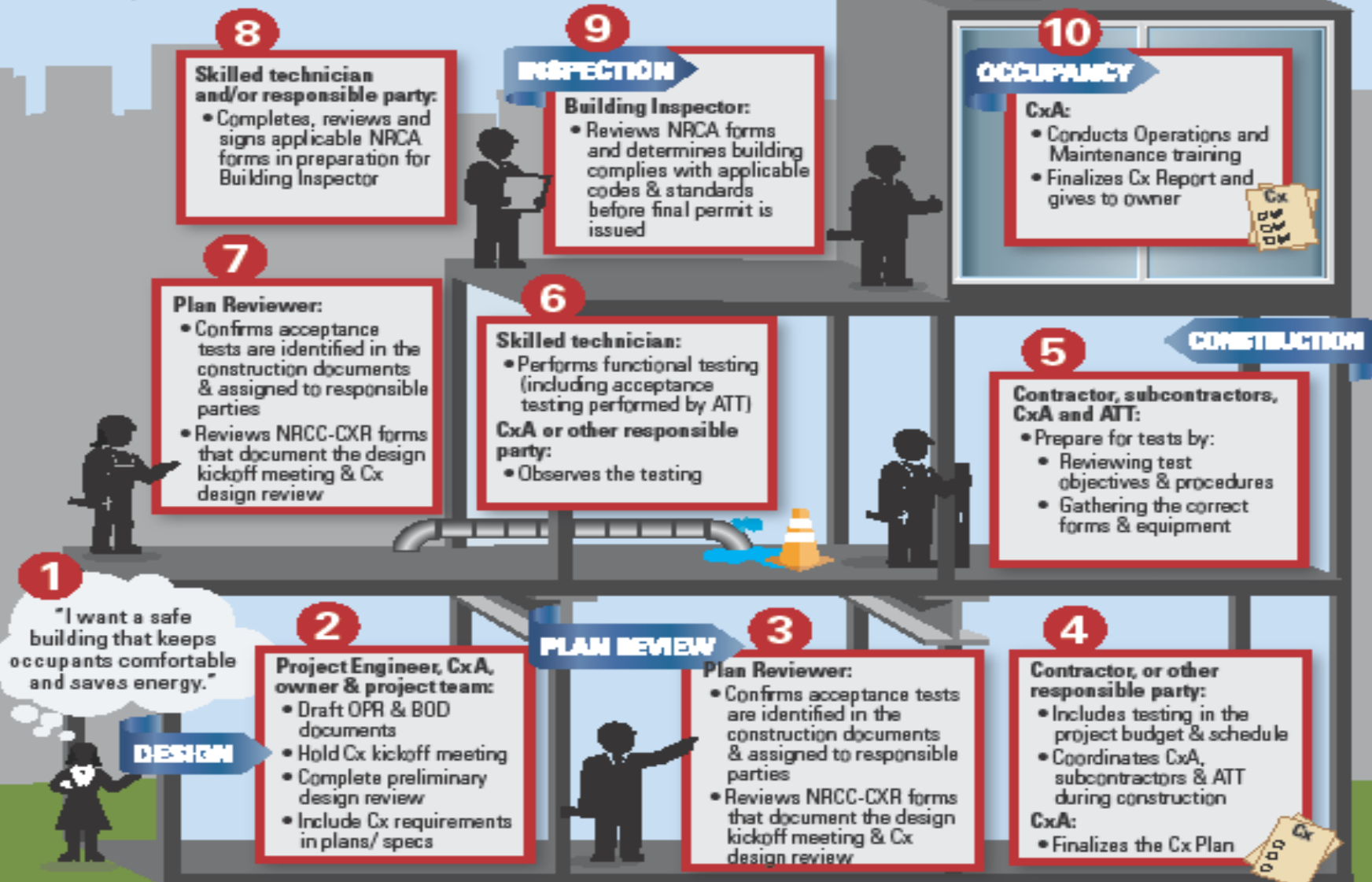
Cx: Commissioning

CxA: Commissioning Authority

NR: Nonresidential

NRCA/NRCC: Title 24 Part 6

Compliance forms



# Construction Timeline



# Construction Timeline

OPR  
BOD

## 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.



Reference: 2016 Nonresidential Compliance Manual, Chapter 12: Building Commissioning Guide

# 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

Reference: 2016 Nonresidential Compliance Manual, Chapter 12: Building Commissioning Guide



# 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

OPR  
BOD

Comp

## 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.

Reference: 2016 Nonresidential Compliance Manual, Chapter 12: Building Commissioning Guide



# Construction Timeline

## 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.



# Construction Timeline

## 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.




# Construction Timeline

## 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



Reference: 2016 Nonresidential Compliance Manual, Chapter 12: Building Commissioning Guide

# 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

OPR  
BOD

App

Comp

Application for Building Permit (Section 10-103(a)2)

- All Required NRCC forms

# Construction Timeline

Quick look at the required documents so far:

## Certificates of Compliance (Commissioning)

Design Review Kick Off  
NRCC-CXR-01-E

### 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

**Simple HVAC - Sections A and B**

A - General Information

**B - Design Review Check List**

**(Fan Systems and Controls)**

And either of these  
Construction Documents:

Simple HVAC

NRCC-CXR-03-E

Complex HVAC

NRCC-CXR-04-E

# 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

**Complex HVAC - Sections A and B**

A - General Information

**B - Design Review Check List**

Fan Systems

Supply Air Temperature Reset

Heat Rejection Equipment

Chillers and Boilers

Hydronic Systems - Plumbing

Hydronic Heat Pump

# 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

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

## 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:

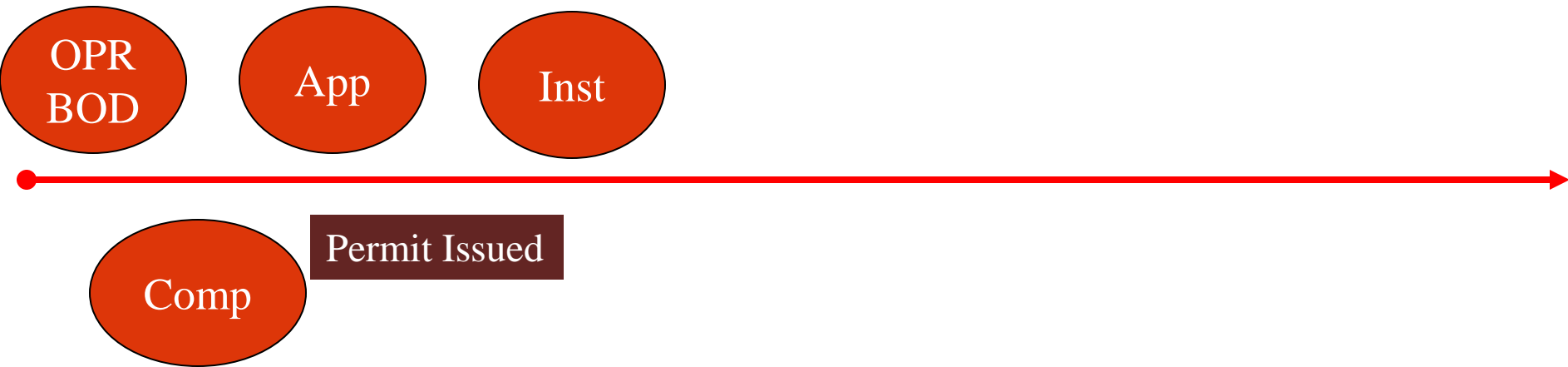
<b>OPR &amp; BOD</b>	Approved by the AHJ at their discretion
<b>Design Review</b>	Approved by the AHJ at their discretion
<b>Commissioning Measures</b>	Approved by the AHJ at their discretion
<b>Commissioning Plan</b>	Approved by the AHJ at their discretion
<b>Commissioning Documents</b>	Approved by the AHJ - Planning
<b>Certificates of Compliance</b>	Approved by the AHJ - Planning



# Construction Timeline



# Construction Timeline



Certificate of Installation (Section 10-103(a)3)

- All Required NRCI forms



# Construction Timeline

Quick look at the required forms so far:

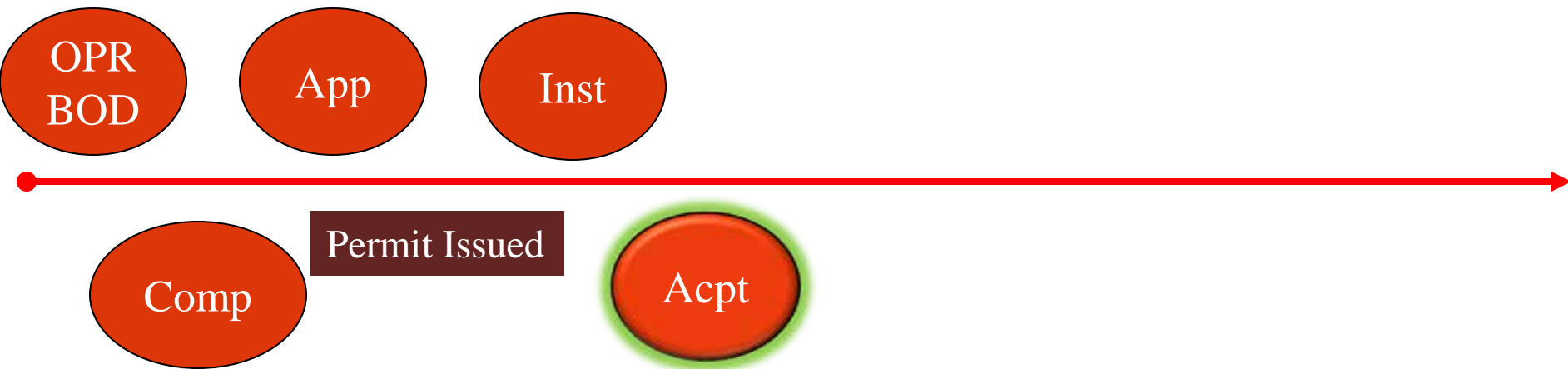
<u>Certificates of Installation</u>	
Electrical Power Distribution NRCI-ELC-01-E	Mechanical Systems NRCI-MCH-01-E
Envelope NRCI-ENV-01-E	Plumbing NRCI-PLB-01-E to 03-E NRCI-PLB-21 & 22-HERS
Indoor Lighting NRCI-LTI-01-E to 06-E	Covered Process NRCI-PRC-01-E
Outdoor Lighting NRCI-LTO-01-E to 02-E	Solar Photovoltaic & Water Heating NRCI-SPV-01-E NRCI-STH-01-E
Sign Lighting NRCI-LTS-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:

## Certificates of Acceptance

Envelope (Fenestration)

NRCA-ENV-02-F

Indoor Lighting (Certified ATT Req)

NRCA-LTI-02-A to 05-A

Outdoor Lighting (Certified ATT Req)

NRCA-LTO-02-A

Mechanical Systems

NRCA-MCH-01-A to 17-A

NRCA-MCH-04-H (duct testing)

Covered Process

NRCA-PRC-01-F to 08-F

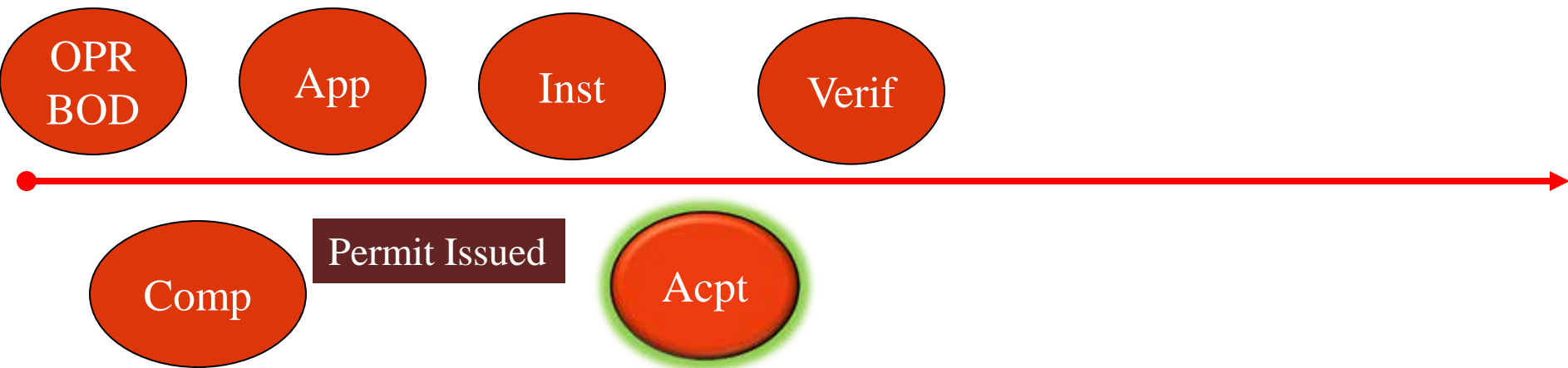
NRCA-PRC-12-F (Elevator)

NRCA-PRC-13-F (Escalator)

Not Required



# Construction Timeline



## 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)

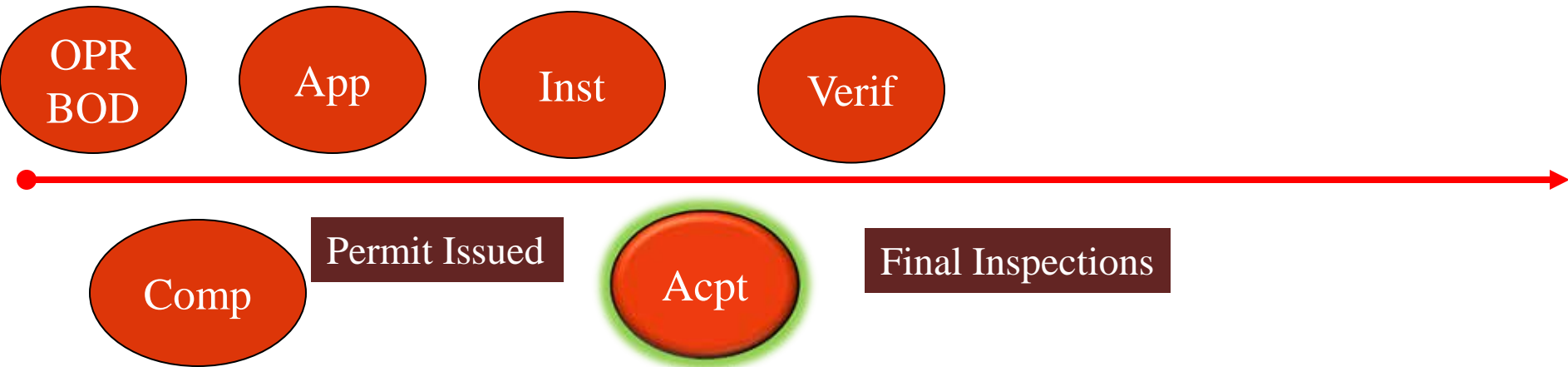
Plumbing (efficient design verification)

NRCV-PLB-21-HERS

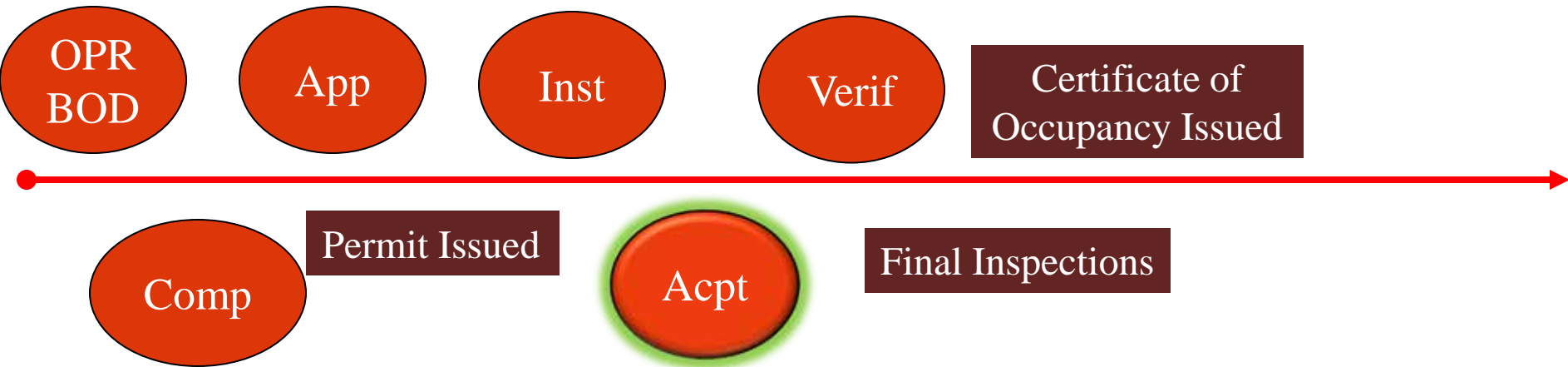
NRCV-PLB-22-HERS



# Construction Timeline



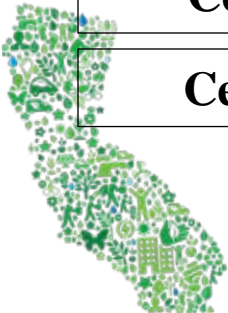
# Construction Timeline



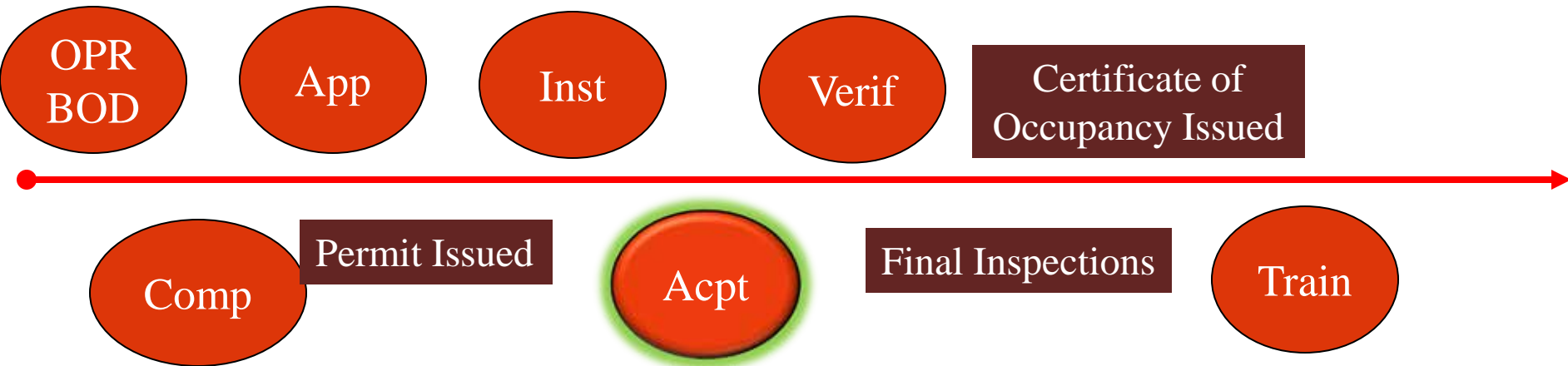
# Construction Timeline

Quick look at the required documents so far:

<b>OPR &amp; BOD</b>	Approved by the AHJ at their discretion
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<b>Commissioning Plan</b>	Approved by the AHJ at their discretion
<b>Certificates of Commissioning</b>	Approved by the AHJ - Planning
<b>Commissioning Documents</b>	Approved by the AHJ - Planning
<b>Certificates of Installation</b>	Approved by the AHJ – Field Inspection
<b>Certificates of Acceptance</b>	Approved by the AHJ – Field Inspection
<b>Certificates of Verification</b>	Approved by the AHJ – Field Inspection



# Construction Timeline



Commissioning Documentation and Training

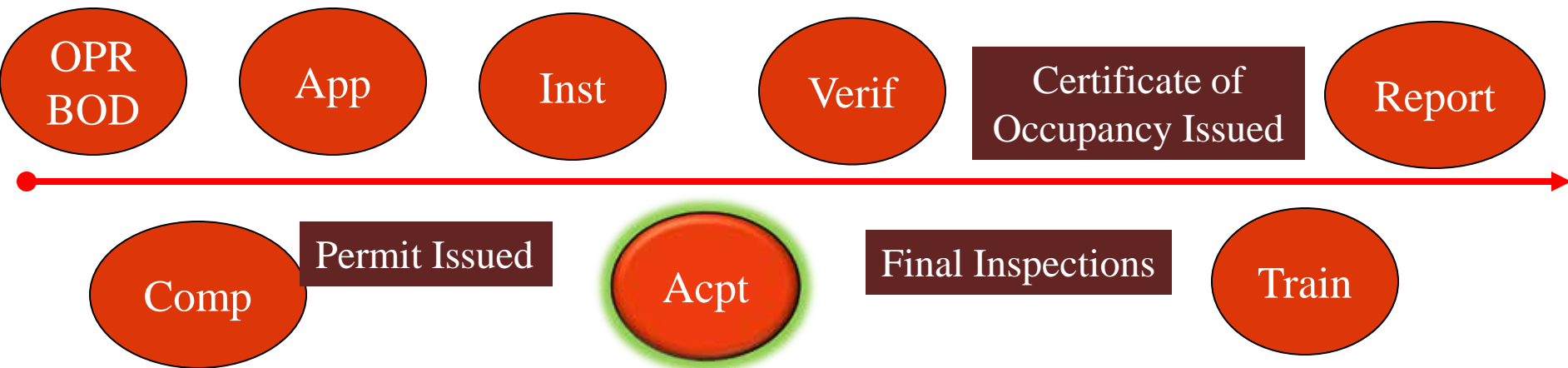
(Section 120.8(h))

System manuals and systems operations training





# Construction Timeline



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.



Reference: 2016 Nonresidential Compliance Manual, Chapter 12: Building Commissioning Guide

# 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

Reference: 2016 Nonresidential Compliance Manual, Chapter 12: Building Commissioning Guide



# 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

Reference: 2016 Nonresidential Compliance Manual, Chapter 12: Building Commissioning Guide



# 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

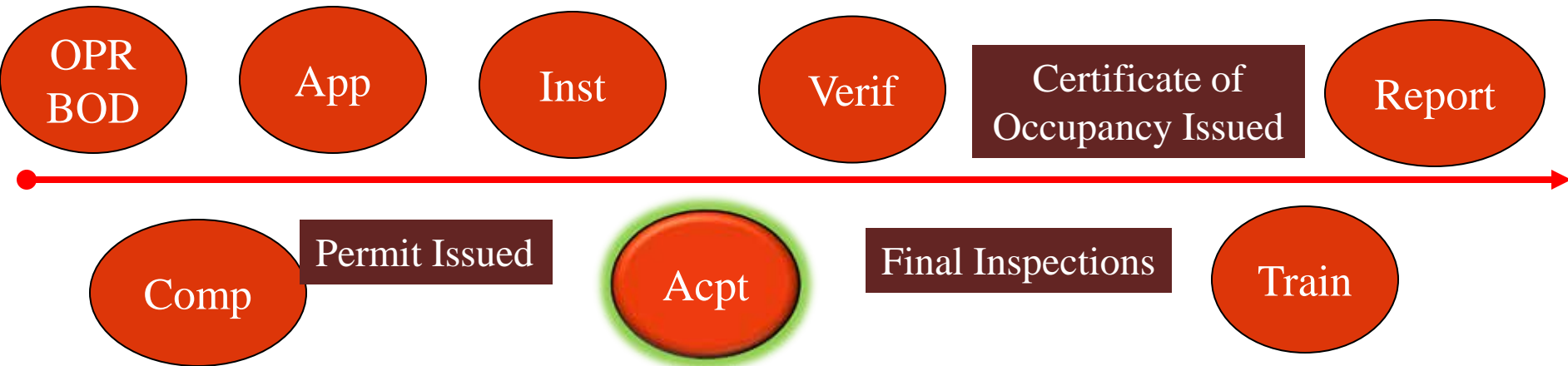


# Construction Timeline

A final look at the required documents:

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<b>Certificates of Acceptance</b>	Approved by the AHJ – Field Inspection
<b>Certificates of Verification</b>	Approved by the AHJ – Field Inspection
<b>Commissioning Documentation and Training</b>	Approved by the AHJ at their discretion
<b>Commissioning Report</b>	Approved by the AHJ at their discretion

# Construction Timeline



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

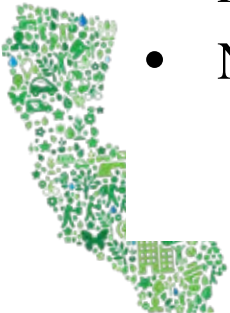
2016 Title 24, Part 1, Section 10-103.1 and 10-103.2

## 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](#))



# 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

5  
Forms

Controls

Mech

17+  
Forms

Nonresidential Data Registry

Commissioning

Electrical

Envelope

Lighting (Indoor, Outdoor)

Solar (Solar Ready, PV, Thermal Heating)

97+  
Forms

Mechanical

Process

Certificate of Compliance

Certificate of Installation

Certificate of Acceptance

Certificate of Verification



# 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)
- Nonresidential Compliance Manual - Chapter 12, Building Commissioning Guide: [http://www.energy.ca.gov/2015publications/CEC-400-2015-033/chapters/chapter\\_12\\_building\\_commissioning\\_guide.pdf](http://www.energy.ca.gov/2015publications/CEC-400-2015-033/chapters/chapter_12_building_commissioning_guide.pdf)
- ListServ (Efficiency, Building Standards, Blueprint): <http://www.energy.ca.gov/efficiency/listservers.html>
- Blueprint: <http://www.energy.ca.gov/efficiency/blueprint/>
- Energy Code Ace: <http://energycodeace.com/>
- Energy Design Resources Website: <http://energydesignresources.com/>
- ATTCP Program: <http://www.energy.ca.gov/title24/attcp/>
- California Commissioning Collaborative <http://www.cacx.org/>



# Questions?

