PIN 70 Electrical Coordination

Bill Gow, P.E.
HCAI Senior Electrical Engineer
916-440-8417
RegsUnit@hcai.ca.gov

Jamie Schnick, P.E.
HCAI Senior Electrical Engineer
213-897-7651
RegsUnit@hcai.ca.gov

March 23, 2022

1

Agenda

- Purpose of Electrical Coordination
- Overview of Code Requirements
- Frequently Asked Questions
- HCAI PIN 70 Plan Review Expectations
- Examples
- Submitting Coordination Studies to HCAI

2

Purpose of Electrical Coordination

3

HCAI Department of Health Care Access and Information

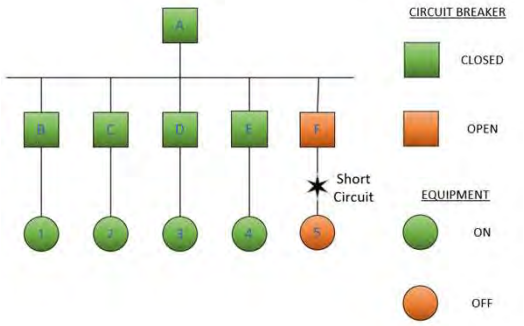
What is the Purpose of Electrical Coordination?

- Electrical coordination is a protective method for selecting and configuring circuit breakers and fuses in an electrical system to localize outages caused by an overcurrent condition.
- When done correctly, only the overcurrent protective device (OCPD) directly upstream of the overcurrent conditions will open clearing the overcurrent condition.
- All other OCPDs upstream of this OCPD will remain closed allowing the remaining electrical system to continue to be energized and operational.

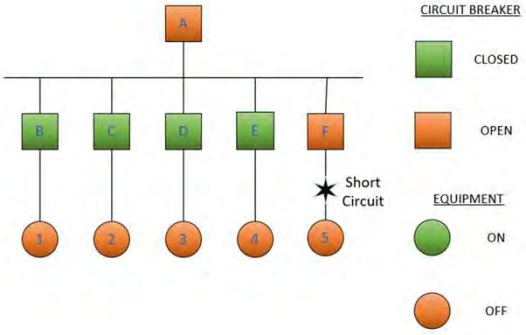
4

HCAI Department of Health Care Access and Information

Coordinated Electrical System



Non-Coordinated Electrical System



5

HCAI Department of Health Care Access and Information

Overview of Code Requirements

6

HCAI Department of Health Care Access and Information

Electrical Coordination Requirements for Health Facilities Essential Electrical Systems

- Type 1 Essential Electrical Systems per 2019 CEC 517.31(G) {Added to CEC in 2016}
  - Note: For 2007 – 2013 code cycle, Type 1 Essential Electrical Systems were required to meet the selective coordination requirements in Article 700
- Type 2 Essential Electrical Systems per 2019 CEC 517.26 and 700.32 {Added to CEC in 2007}
- Essential Electrical Systems Coordination per 2018 NFPA 99: 6.7.2.2.2 {Added to NFPA 99 in 2012}

7

HCAI Department of Health Care Access and Information

Other Electrical Coordination Requirements Applicable for Health Facilities

- Elevators Supplied by Common Feeder per 2019 CEC 620.62 {Added to CEC in 1998}
- Fire Pumps used in Multibuilding Campus-Style Complexes per 2019 CEC 695.3(C)(3) {Added to CEC in 2013}

8

HCAI Department of Health Care Access and Information

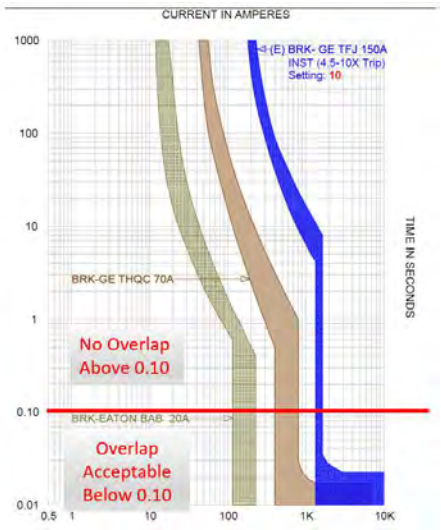
Other Electrical Coordination Requirements

- Emergency Systems per 2019 CEC 700.32 {Added to CEC in 2007}
- Legally Required Standby Systems per 2019 CEC 701.27 {Added to CEC in 2007}

9

Type 1 Essential Electrical Systems Coordination [CEC 517.31(G)]

- Overcurrent protective must coordinate for the period of time that a fault's duration extends beyond 0.1 second. (See curves)
- Exception No. 1: Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary.
- Exception No. 2: Between overcurrent protective devices of the same size (ampere rating) in series.
- NOTE: HCAI allows Type 2 Essential Electrical System to meet 0.1 second coordination requirement rather than selective coordination requirement of 700.32. This aligns with NFPA 99.

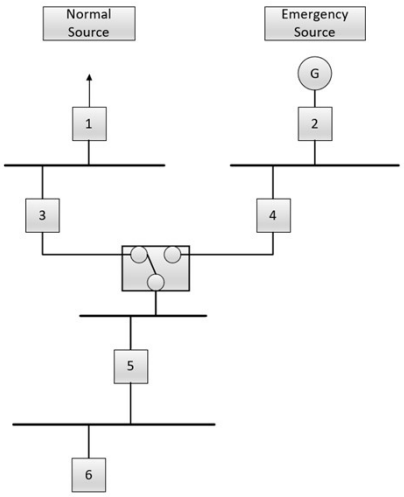


OCPD Time Current Curves

10

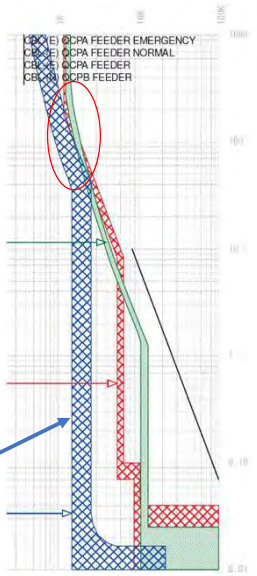
Type 1 and Type 2 Essential Electrical Systems Coordination Explanation

- OCPD 6 coordinates with OCPDs 5, 3, 4, 1, and 2.
- OCPD 5 coordinates with OCPDs 3, 4, 1, and 2.
- OCPD 4 coordinates with OCPD 2.
- OCPD 3 is not required to coordinate with OCPD 1 because OCPD 3 is not an essential electrical system OCPD.
- Source: 2020 NEC 700.32 Information Note.

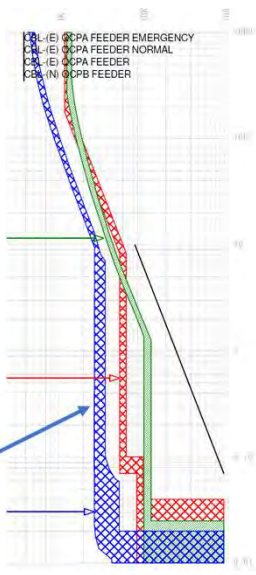


11

The right type of circuit breaker is important



400A Adjustable Thermal Magnetic Circuit Breaker



400A Electronic Trip Circuit Breaker

12

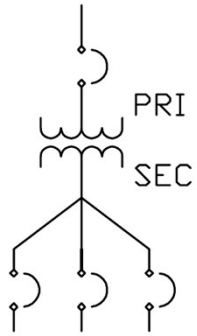
Exception No. 1: Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary.

Exception No. 1

Coordination Not Required Between PRI and SEC

NOT Exception No. 1

Coordination Required Between PRI and SEC

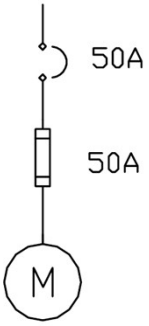


13

Exception No. 2: Between overcurrent protective devices of the same size (ampere rating) in series.

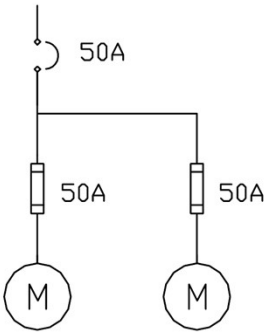
Exception No. 2

Coordination Not Required Between CB and Fuse



NOT Exception No. 2

Coordination Required Between CB and Fuses

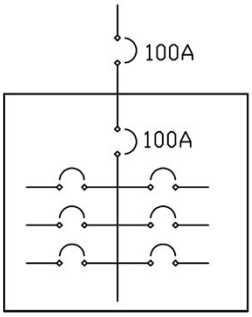


14

Exception No. 2: Between overcurrent protective devices of the same size (ampere rating) in series.

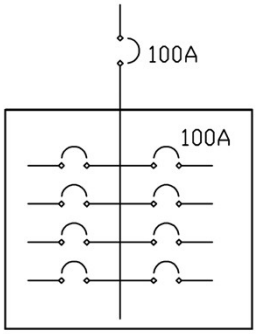
Exception No. 2

Coordination Not Required Between 100A CBs



NOT Exception No. 2

Coordination Required Between 100A CBs



15

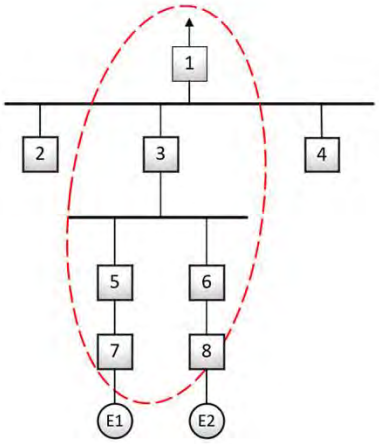
HCAI Department of Health Care Access and Information

Elevators Supplied by Common Feeder (CEC 620.62)

- Where more than one driving machine disconnecting means is supplied by a single feeder, OCPDs in each disconnecting means shall selectively coordinate with upstream feeder OCPDs for the full range of available overcurrents, from overload to the available fault current, and for the full range of OCPD.

HCAI interpretation:

- OCPD 7 & 8 are elevator disconnect overcurrent protective devices.
- OCPD 7 & 8 must selectively coordinate with OCPD 1 & 3.
- OCPD 7 does not need to coordinate with 5 because they are in series.
- OCPD 8 does not need to coordinate with 6 because they are in series.
- OCPD 5 & 6 do not need to selectively coordinate with OCPD 1 & 3 but may need to 0.1 second coordinate if part of the essential electrical system.



16

HCAI Department of Health Care Access and Information

Fire Pumps used in Multibuilding Campus-Style Complexes per 2019 CEC 695.3(G)(3)

- 695.3 is not for all fire pump installations. It only applies to fire pumps used in Multibuilding Campus-Style Complexes.
- 695.3 requires the fire pump overcurrent protective device(s) in each disconnecting means to be selectively coordinated with any other supply-side overcurrent protective device(s).
- NOTE: All fire pumps powered by the essential electrical system must meet the essential electrical systems coordination requirements.

17

HCAI Department of Health Care Access and Information

Frequently Asked Questions

18

HCAI Department of Health Care Access and Information

PIN 70 is new. Does a project currently in construction need to meet the applicable electrical coordination requirement? Yes

- Electrical coordination is not a new code requirement.
- For example, “Selective Coordination Study and Testing” was listed on the 2013 TIO.
- PIN 70 was created as a guide for the healthcare industry.
- PIN 70 aligns with HCAI CAN 2-102.6 Remodel which requires all new elements of construction must comply with current code.
- PIN 70 aligns with NFPA 99 which requires the altered, renovated, or modernized portion of an existing system to meet the current NFPA 99 installation requirements.

19

HCAI Department of Health Care Access and Information

Is a coordination study required for a new 20A circuit breaker in the Essential Electrical System? Yes

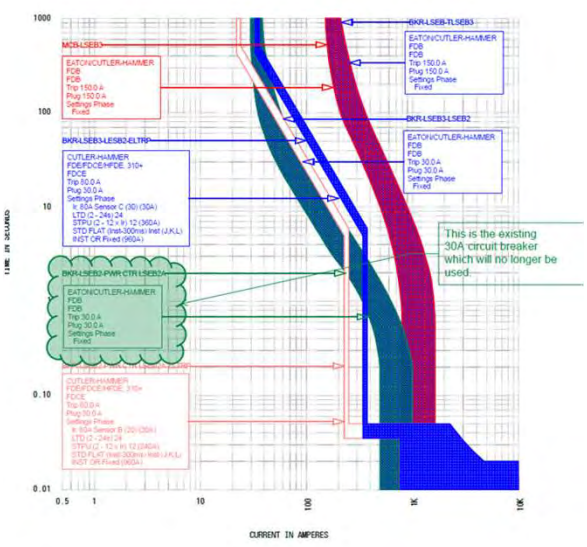
- Why? Because an overcurrent of a 20A circuit breaker might trip the upstream feeder circuit breakers.
- From the 2017 NEC Handbook for 700.32
  - Continuity of operation of lighting and life-safety equipment is necessary for safe occupant evacuation. This requirement minimizes the possibility that an overload, short circuit, or ground fault in a 20-ampere branch circuit would cause the feeder protective device supplying the branch-circuit panelboard to open. Coordination must be carried through each level of distribution that supplies power to the emergency system.
- The substantiation for the original (2005) NEC® proposal for Section 700.27 stated
  - With the interaction of this Article for emergency lighting for egress, it is imperative that the lighting system remain operational in an emergency. Failure of one component must not result in a condition where a means of egress will be in total darkness as shown in [Section] 700.16…. Selectively coordinated overcurrent protective devices will provide a system that will support all these requirements and principles.

20

HCAI Department of Health Care Access and Information

Is there a magic ratio so coordination study is not required? No

- Example of 30A circuit breaker (green curve) does not coordinate with 150A circuit breaker (pink curve).
- Note: PIN 70 states HCAI plan reviewer will make a blue pencil comment (i.e., non-enforceable comment) when the overcurrent devices requiring coordination is less than 3:1 ratio if a coordination study is not submitted during plan review. This is just a FYI, it is not a magic ratio. **A coordination study is still required.**



21

Are SNF (TYPE 2) Essential Electrical Systems Required to Coordinate? Yes

- CEC 517.26 requires life safety branch, critical branch, and equipment branch to meet the requirements of Article 700 except as amended by Article 517.
- Therefore, TYPE 2 Essential Electrical Systems need to meet the coordination requirements in Article 700.
- HCAI only requires 0.1 second coordination instead of selective coordination.
- This aligns with the coordination requirements in NFPA 99.

22

Can manufacturer coordination tables can be used in lieu of time current curves in the coordination study? Yes

- Tables need to be provided with coordination study and clearly indicate coordinating OCPDs.
- Coordination study needs to list manufacturers, model numbers, current ratings, devices settings, etc.

23

What's Required in a Coordination Study?

- EEOR shall stamp and sign the cover sheet of the electrical coordination study [CAC 7-115].
- AOR shall sign the cover sheet of the electrical coordination study [CAC 7-115].
- A summary stating that all overcurrent protective devices identified in the report meet the applicable coordinated requirements.
  - 0.1 second coordination for ESS
  - Selective coordination for other systems
- Manufacturer, model number, current ratings of OCPDs and settings for adjustable circuit breakers
- Time current curves or data from manufacture which demonstrate electrical coordination
- Electrical single line diagrams
- Available fault current for systems requiring "selective coordination"

24

Can a Coordination Study be Part of a Power System Study? Yes

- Power System Study general covers the following areas:
  - Short-Circuit Study
  - Coordination Study
  - Risk Assessment Study (Arc Flash Study)
  - Other Electrical Studies
  - See NFPA 70B for additional information regarding Power System Studies
- HCAI will review Coordination Study and Short-Circuit Study
- HCAI will not evaluate the arc flash study except as required in CEC 110.16
- HCAI will not be evaluating other electrical studies

25

HCAI Department of Health Care Access and Information

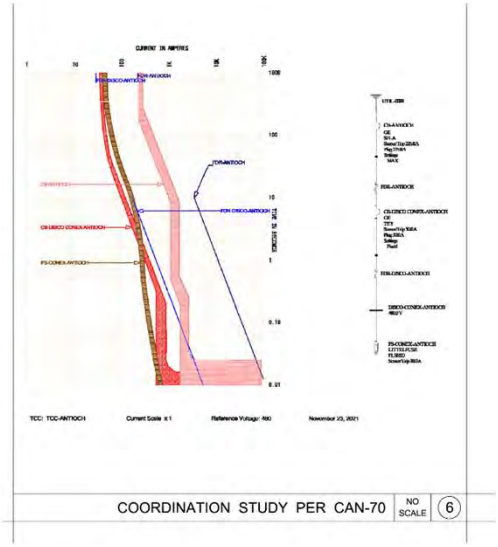
Can a Coordination Study Include Time Current Curves for Normal System? Yes

- HCAI will not review these normal system settings or time current curves except for the case of elevators supplied by common feeder.
- Help HCAI by making it clear which system is associated with each time current curve.

26

HCAI Department of Health Care Access and Information

Can Electrical Coordination Study be part of the Electrical Plans? Yes



27

HCAI PIN 70 Plan Review Expectations

28

PIN 70 Policy

- All new and repurposed existing OCPDs must coordinate with the new and existing electrical system as required by the California Electrical Code (CEC).
- The electrical plans must demonstrate that the electrical system will meet coordination requirements during plan review.
- A final coordination study demonstrating code compliance is required to be produced during plan review phase or during the construction phase as a deferred submittal.
- When there are changes to the electrical design during construction that affects overcurrent protection devices coordination, an Amended Construction Document (ACD) shall be issued with the revised electrical plans and specifications, and an updated final coordination study.

29

HCAI Department of Health Care Access and Information

PIN 70 Procedure

- The following are acceptable means of demonstrating coordination during plan review:
  - Option 1: Provide a final coordination study demonstrating the new work meets the coordination requirements.
  - Option 2: Provide a preliminary coordination study demonstrating that new OCPDs shown in plans and specifications will meet the coordination requirements.
  - Option 3: Provide a letter or note on the electrical drawings signed by the EEOR stating that the essential electrical system has been evaluated for coordination and the essential electrical system will meet the coordination requirements of the CEC, Article 517.
- Identify OCPDs requiring electrical coordination on electrical plans.
  - Designation methods can be sheets notes, note callouts, boundary lines on SLD, list of equipment, etc.
- When the final coordination study will be submitted during the construction phase, “Electrical Coordination Study” shall be listed as a Deferred Approval Items (DSI) on the project cover sheet during plan review.

30

HCAI Department of Health Care Access and Information

Example of Letter or Note on the Drawings Signed by the EEOR

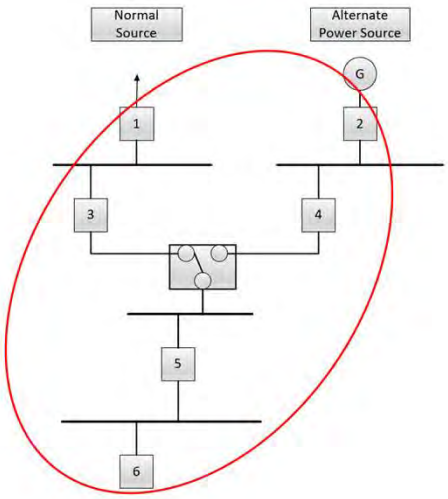
The formal documentation of electrical system coordination is being submitted as a deferred approval, and is shown as such on the project cover sheet. By my signature and stamp below, I certify that I have evaluated the electrical system for coordination and determined that the design presented here is capable of meeting the requirements of HCAI PIN 70 and the California Electrical Code, including CEC Articles 517, 620, and 695.

31

HCAI Department of Health Care Access and Information

Coordination Study for New Essential Electrical System

- All Essential Electrical System Overcurrent Protective Devices (OCPDs)
  - OCPD 6 coordinates with OCPD 5, 3, 4, 1, and 2
  - OCPD 5 coordinates with OCPD 3, 4, 1, and 2
  - OCPD 4 coordinates with OCPD 2
  - OCPD 3 is <u>not</u> required to coordinate with OCPD 1 because OCPD 3 is not an essential electrical system OCPD

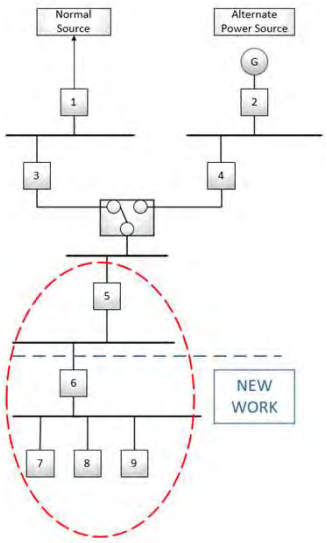


32

HCAI Department of Health Care Access and Information

New Work on Existing Essential Electrical System

- Examples of new work
  - Installation of circuit breakers, fused disconnect switches, electrical panelboards, switchgear, switchboards, substations, motor control centers, and other equipment with OCPDs.
  - Repurposing of spare circuit breakers
  - Changing existing fuses to different sizes
- OCPD 6, 7, 8, & 9 are new overcurrent protective devices connected to an existing electrical system.
- OCPD 7, 8, & 9 must coordinate with OCPD 5 & 6.
- OCPD 6 coordinates with OCPD 5

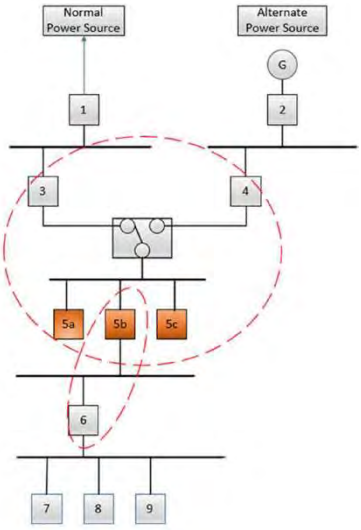


33

HCAI Department of Health Care Access and Information

Replacement of Essential Electrical System Electrical Panelboards, Switchgear, Switchboards, Substations, and Motor Control Centers

- Circuit Breakers 5a, 5b, and 5c are part of an electrical panel replacement.
- Circuit Breakers 1, 2, 3, 4, 6, 7, 8, & 9 are existing.
- Circuit Breakers 5a, 5b, & 5c must coordinate with the existing circuit breakers 3 & 4 which are one-level upstream.
- Circuit Breaker 5b must coordinate with the existing circuit breaker 6 which are one-level downstream.
- Circuit Breakers 1, 2, 7, 8, & 9 are not in the project scope, so coordination is not required to be evaluated.



34

HCAI Department of Health Care Access and Information

Replacement in Kind of Utilization Equipment Powered by Essential Electrical System

- Evaluation of electrical coordination will not be required if:
  - Same type of utilization equipment
  - Reconnect to same OCPD
  - Existing branch circuit OCPD is reduced in the size if the size reduction is required by the new utilization equipment installation
- Evaluation of electrical coordination will be required if replacement utilization equipment is connected to:
  - Larger sized OCPD
  - OCPD in different electrical panel.

35

HCAI Department of Health Care Access and Information

Replacement of Essential Electrical System Individual OCPDs

- Any OCPD can be replaced due to malfunction or age without requiring electrical coordination to be verified.
- OCPD must be replaced with same type and electrical rating and reconnected to existing load.

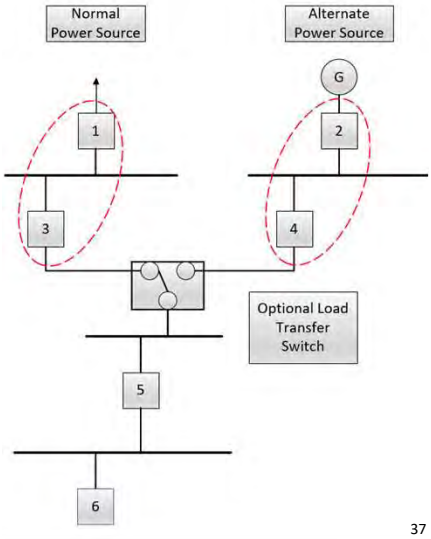
NOTE: OCPDs installed under electrical code prior to 2007 editions are not expected to coordinate.

36

HCAI Department of Health Care Access and Information

Optional Load Branch

- Normal and essential electrical systems OCPDs supplying an optional load transfer switch allowed in 517.31(B)(1) shall coordinate with upstream OCPDs.
  - OCPD 3 coordinates with OCPD 1
  - OCPD 4 coordinates with OCPD 2
- The purpose of this requirement is to localize any optional load overcurrent outages to the optional branch so that the remaining essential electrical system remains energized.
- Remaining OCPDs downstream of the optional load transfer switch (i.e., OCPD 5 and 6) are not required to coordinate.



37

HCAI Department of Health Care Access and Information

Emergency Systems and Legally Required Standby Systems (CEC 700.32 and 701.27)

- PIN 70 requirements for emergency systems and legally required standby systems are similar to the essential electrical system requirement except OCPDs need to meet the stricter selective coordination requirements.
- Note: these requirements are not applicable for Health Facilities Essential Electrical Systems.

38

HCAI Department of Health Care Access and Information

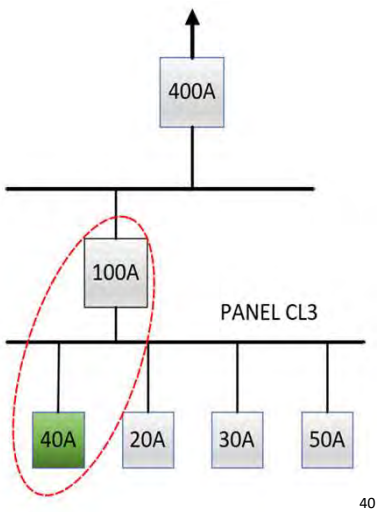
Examples

39

HCAI Department of Health Care Access and Information

Example A: Installation of New Circuit Breaker to an Existing Critical Branch Panel for New Electrical Utilization Equipment

- New 40 amp circuit breaker is being added to an existing critical branch PANEL CL3.
- PANEL CL3 is fed from a 100 amp feeder breaker.
- PANEL CL3 has a mix of existing branch circuit breakers ranging in value from 20 amp to 50 amp.
- A coordination study is required demonstrating the new 40 amp circuit breaker will coordinate with existing upstream 100 amp feeder breaker since this is the point of connection to the existing essential electrical system.
- HCAI will not require coordination to be evaluated for circuit breakers above the 100 amp circuit breaker feeding PANEL CL3.
- HCAI will not require coordination to be evaluated between the 100 amp circuit breaker and the existing circuit breakers in PANEL CL3.

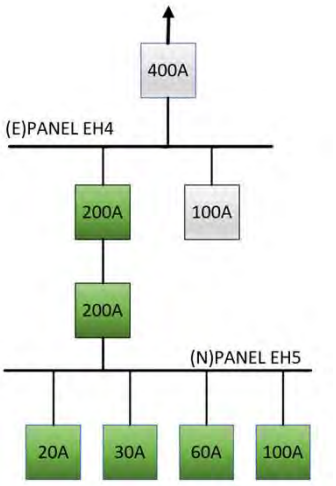


40

HCAI Department of Health Care Access and Information

Example B: Installation of New Subpanel Fed from Existing Equipment Branch Panel

- Existing PANEL EH4 is fed by 400A feeder breaker.
- New 200A breaker is added to PANEL EH4 to feed new subpanel PANEL EH5.
- New PANEL EH5 has a 200A main, 20A, 30A, 60A and 100A breakers.
- The coordination study needs to show coordination between:
  - 400A feeder breaker for PANEL EH4 and the new 200A breaker in PANEL EH4
  - 400A feeder breaker for PANEL EH4 and the new 200A main breaker in PANEL EH5
  - New 200A breaker in PANEL EH4 and new breakers in PANEL EH5
  - New 200A main breaker in PANEL EH5 and new breakers in PANEL EH5
- New 200A breaker in PANEL EH4 and the new 200A main breaker in PANEL EH5 are in series, and not required to coordinate with each other per 517.31(G) Exception No. 2.



41

Example C: Spare Circuit Breaker Used to Connect New Electrical Equipment

- A spare circuit breaker is being used to supply power to a new subpanel or new utilization equipment.
- The spare breaker is treated the same as the new circuit breaker in Example A and B.
- This spare circuit breaker will need to coordinate with OCPDs upstream and downstream from the spare circuit breaker.

42

Example D: Replacement-in-Kind of Electrical Utilization Equipment

- Examples of utilization equipment are appliances, luminaires, HVAC equipment, machinery, and medical equipment.
- If the replaced utilization equipment is connected to the same existing electrical circuit and the OCPD remains unchanged, then coordination of OCPD supplying power to this utilization equipment does not need to be evaluated because it is the existing condition.
- If the replaced utilization equipment is connected to the same existing electrical circuit but the OCPD rating is reduced in size to match manufacturers installation instructions, then coordination of OCPD supplying power to this utilization equipment does not need to be evaluated because coordination would be equal or increased by this change.
- If the replaced utilization equipment is connected to the same existing electrical circuit but the OCPD is increased, then coordination of OCPD supplying power to the utilization equipment will be required as described in Example A.

43

HCAI Department of Health Care Access and Information

Example E: Relocation of Electrical Equipment or Utilization Equipment

- Coordination will not be required to be evaluated when existing equipment is relocated and reconnect to the same existing OCPD.
- Coordination will be required when the relocated equipment is connected to a different OCPD.

44

HCAI Department of Health Care Access and Information

Example F: Upgrade Medical Equipment

- When medical equipment is upgraded and requires new OCPD to be installed, new OCPD shall coordinate as required in Example A.

45

Example H: Replacement of Elevator Disconnecting Means

- When elevator disconnecting means is being replaced and more than one machine disconnecting means is supplied by a single feeder as described in the CEC 620.62, then new elevator disconnecting means must be selectively coordinated with the other supply side OCPDs.

46

Example I: Replacement of Overcurrent Protective Devices for Fire Pump Powered by Feeder Source in Multibuilding Campus-Style Complex

- When OCPDs are being replaced for a fire pump powered by feeder source in multibuilding campus-style complex, OCPDs must be selectively coordinated with any other supply-side OCPDs per the CEC 695.3(C)(3).
- Note: this requirement does not apply to all fire pump installations.

47

HCAI Department of Health Care Access and Information

Example J: Adding Overcurrent Protective Devices for any Fire Pump Fed by the Essential Electrical System

- When OCPD is being added for any fire pump powered by the Essential Electrical System, OCPD is treated like another essential electrical system load and only required to coordinate for the period of time that a fault's duration extends beyond 0.1 second per CEC 517.31(G).

48

HCAI Department of Health Care Access and Information

Submitting Electrical Coordination Studies to HCAI

49

HCAI Department of Health Care Access and Information

Fix All Problems Before Submitting Coordination Studies for Approval

ii. See TCC's #2-1, #2-2, and #2-3: The specified 225A branch breakers in Panel E3LA3/05006 will not coordinate with the upstream 400A microprocessor trip breakers, even with low instantaneous settings. 175A branch breakers would be the largest that will coordinate. Recommended Action: change (5) 225A breakers to 175A.

iii. See TCC's #3-1 and #3-2: Existing ATS #4 is fed from 225A fuses in normal Panel NHA1/0073. This does not match the drawings which note these as 400A. These fuses will not coordinate with downstream breakers, and are recommended to be changed to 400A. Recommended Action: change (3) 225A fuses to 400A.

- Revised Plans can be submitted with the Coordination Study

Reminder: Verify the sizes of the OCPDs in the Coordination Study match the approved plans.

50

HCAI Department of Health Care Access and Information

Required Signatures (CAC 7-115)

- EEOR shall stamp and sign the cover sheet of the electrical coordination study [CAC 7-115(b)]
  - HCAI understands third-party electrical engineers may assist the EEOR in the development of the coordination study, but the EEOR is responsible for the electrical design including electrical coordination.
  - Third-party electrical engineers may stamp the coordination study as required by PE Acy, but they are not required to be list as design professional of record on the HCAI application.
- AOR sign the cover sheet of the electrical coordination study [CAC 7.115(a)]

51

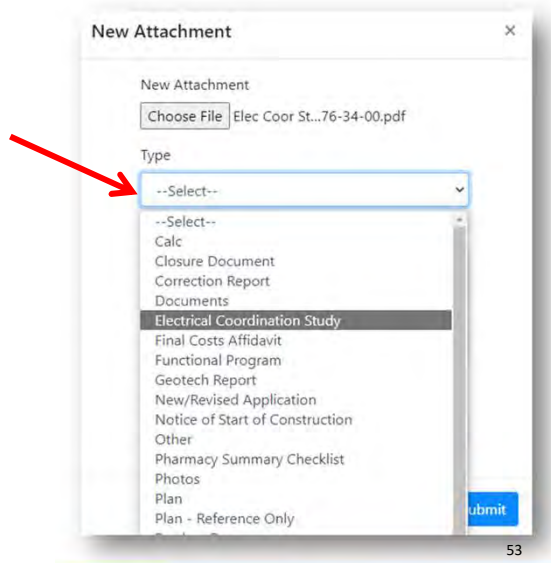
Deferred Submittal (DSI) or Amended Construction Document (ACD)

- Use DSI for a new project where electrical coordination study will be finalized during construction phases.
  - Approved plans shall list "Electrical Coordination" under DEFERRED APPROVALS on project title sheet.
- Use ACD when there are changes to the electrical design during construction that affects overcurrent protection devices coordination after DSI is approved. ACD should include revised electrical plans/specifications and updated final electrical coordination study.
- Use ACD for existing approved projects when submitting the first electrical coordination study to the Office.

52

Uploading - Electrical Coordination Study

Select the document type of "Electrical Coordination Study" when uploading electrical coordination studies in eServices Portal.

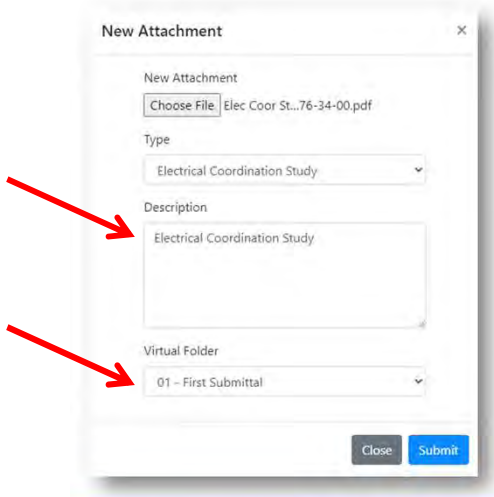


53

HCAI Department of Health Care Access and Information

Uploading - Electrical Coordination Study

The other fields should look similar to this…..

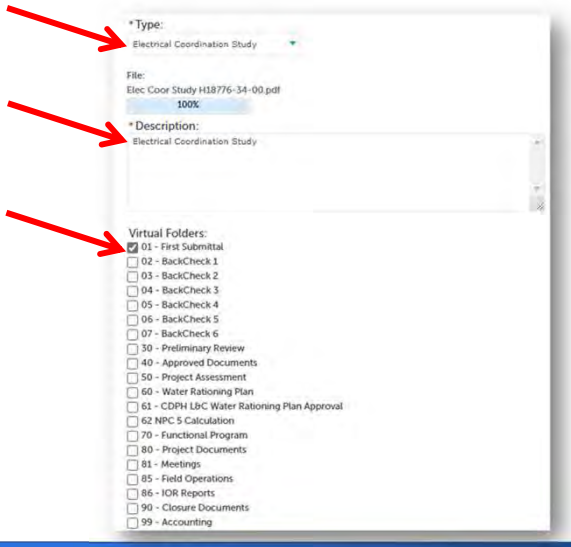


54

HCAI Department of Health Care Access and Information

Uploading - Electrical Coordination Study

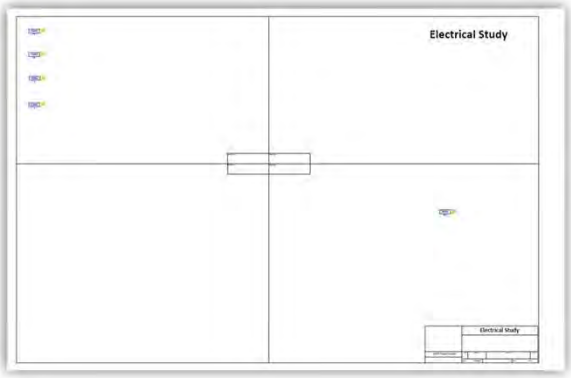
If you are using the alternate attachment portal, the same rules apply, just a different layout.



55

Uploading - Electrical Coordination Study

If the coordination study is not accompanied by a Plan file, HCAI staff will add a placeholder “Plan” in order to log comments



56

Uploading Plan – Reference Only

- If electrical plans are not being revised based on coordination study, please consider uploading the latest approved single line diagram and essential electrical system panel schedules as reference only documents.

57

Backchecks - Electrical Coordination Study

- You do not have to upload a placeholder “Plan” for backcheck review – just the revised Electrical Coordination study and a Response to Comments (Excel) file.

58

Questions?

RegsUnit@hcai.ca.gov

59

HCAI Department of Health Care Access and Information

AIA California

AIA California

Proudly Partnered with AIA California

Attendees will earn 2 AIA LU/HSW for attending this presentation live.

AIA CA will submit you for AIA credit within 10 days of the presentation.

AIA Continuing Education Provider