Board of Building Standards

EDUCATION COMMITTEE MEETING
AGENDA

DATE: OCTOBER 20, 2022
TIME: 10:00 AM
LOCATION: BBS LIBRARY, 6606 TUSSING ROAD, REYNOLDSBURG, OH 43068
Click here to join the meeting

Call to Order

Consent Agenda

Course Applications

ER-1 Understanding Fire Alarm Basics (Building and Fire Code Academy)
BO, MPE, EPE, BI, FPI (two sessions of 6 hours each)
Staff Notes: Recommend approval, include FPPE, RBO
Committee Recommendation:

Old Business

OB-1 Changes to BBS Education Classification system
At the May meeting BBS staff briefly introduced an updated education approval application which changes the way courses are approved for certifications. Staff email and proposed new application, existing application are attached. Item was tabled in June, bringing back for discussion and adoption.
Committee Recommendation:

OB-2 Education credit for recruitment/outreach activities
Chris Parmelee, BO for Lakewood Ohio, attending to discuss outreach activities he has performed.
Sample reporting form for discussion.

New Business

Adjourn

EDUCATION COMMITTEE MEETING
CONSENT AGENDA

Course Applications

EC-1 Overview of Chapter 1 of the RCO (Kurtz, Robert)
All Certifications (1.5 hours)

EC-2 Appliances (Independent Electrical Contractors)
EPE, ESI, RBO (4 hours)

EC-3 Box Fill (Independent Electrical Contractors)
EPE, ESI, RBO (4 hours)

EC-4 Conductor Types, Ampacities, Correction Factors (Independent Electrical Contractors)
EPE, ESI, RBO (4 hours)

EC-5 Dwelling Circuit Requirements (Independent Electrical Contractors)
EPE, ESI, RBO (4 hours)

EC-6 Grounding and Bonding (Independent Electrical Contractors)
EPE, ESI, RBO (4 hours)

EC-7 Voltage Drop (Independent Electrical Contractors)
EPE, ESI, RBO (4 hours)

File Attachments for Item:

ER-1 Understanding Fire Alarm Basics (Building and Fire Code Academy)

BO, MPE, EPE, BI, FPI (two sessions of 6 hours each)

Staff Notes: Recommend approval, include FPPE, RBO

Committee Recommendation:

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Teresa Wawro
(Contact Name)
Organization: Building & Fire Code Academy
(Organization/Company)
Address: 2420 Vantage Drive
(Include Room Number, Suite, etc.)
City: Elgin State: IL Zip: 60124
E-Mail: twawro@bfcacademy.com
Telephone: 847-428-2951 Fax: 847-428-2911
Course Sponsor:

COURSE INFORMATION:

Course Title: Undrstanding Fire Alarm Basics

New Course Submittal: ■ Update Course: ☐ Prior Approval Number:

Purpose and Objective: A training course structured on Chapter 9, and referenced applicable sections, as well as referencef standards contained there in, of the 2019 Ohio Building Code. Students will be able to: Identify when the building fire codes require fire alarm systems and the components of these systems. When provided with a floor plan students will analyze the floor plan for proper coverage for smoke detectors and alarm notification devices. Determine spacing requirements for differing initiating devices and identify fire alarm systems testing requirements.

Number of Instructional Contact Hours that can be obtained upon completion: 12

If Multi-Session, Number of Instructional Contact Hours Per Session: 6 hours per session, over 2 days

Program Applicable for the Following Participants:

Building Official ■	Master Plans Examiner ■	Building Inspector ■	Fire Protection Inspector ■	Mechanical Inspector ☐
	Plumbing Plans Exam. ☐			Plumbing Inspector ☐
	Electrical Plans Exam. ■			Non-Res IU Inspector ☐
	Mechanical Plans Exam. ☐			

Res Building Official ☐ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☐
Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	x
Course Sponsor:	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	x
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	x
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	x
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	x
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	x
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	x
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	x
Test Materials:	Copy of quizzes or tests to be given	
Completed Application:		x

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Sean A. Fallows

Fire Protection Inspector/Plan Reviewer

EMPLOYMENT HISTORY

B&F Construction Code Services 2015–Present

-Fire Protection Plans Reviewer and Inspector
-Fire Protection Supervisor & Special Projects Coordinator – which included Building, Electrical, Mechanical and Fuel
-Director of Technical Services – oversee all areas of plan review

Freelance Sprinkler Designer 2008-2009; 2012-2015

-Produced fire sprinkler drawings in HydraCAD
-Perform fire sprinkler system calculations
-Field stock sprinkler systems for fabrication
-Manage projects to ensure material, approvals, RFIs, and coordination

TransAmerican Fire Sprinkler Oklahoma City

Fire Sprinkler System Designer / Project Manager 2010-2012

-Design fire sprinkler systems to specifications and code requirements
-Listed fire sprinkler systems for material order and fabrication
-Managed fire sprinkler installation projects costing up to $700,000

Fire By Design Engineering Firm Lake Villa, IL

System Designer 2006–2008

-Produced fire sprinkler and fire alarm designs in AutoCAD
-Conducted building surveys, drew existing building in AutoCAD
-Created designs to architects' specifications
-Created gas detection systems
-Conducted plan review
-Interpreted and created code compliance studies
-Worked on 100+ project

Northbrook Fire Department Northbrook, IL

-Surveyed and calculated occupancy loads for public buildings Prepared presentation materials for NFPA 13D village ordinance 2005–2006
-Completed annual reports
-Compiled employee, accident, and call history reports into electronic format
-Assisted writing department procedures for digital photography for investigations
-Created electronic expense forms post Hurricane Katrina
for MABAS expenses
-Assisted in developing information system for multi-family dwellings tracking persons in need of assistance during evacuation
-Performed plan reviews

EDUCATION

Bachelors of Science, Fire Protection and Safety Technology
Oklahoma State University

PROFESSIONAL SKILLS & ACCOMPLISHMENTS

NICET Level 1 for fire alarm systems & water based system layout

Fundamentals of Engineering Exam

Graduate Safety Practitioner (GSP)

Eagle Scout Award, Boy Scouts of America, Awarded May 2002

OSHA 30 hour course in Construction Safety and Health

Hydratec suite of programs (HydraCAD, HydraCALC, HydraList)

HASS (Hydraulic Analysis of Sprinkler Systems)

NFPA codes and standards & International Code Council (ICC)

AutoCAD drafting, AutoSprink & building surveys

Emergency Responder Training

MEPCAD AutoSprink design software

Xtralis Vesda & Aspire 2 Training

BFCA®
Building & Fire Code Academy

WELCOME

Building Better With Our Greatest Resource…Education®

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Ohio Board of Building Standards

Building Better With Our Greatest Resource…Education®

BFCA

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Thank you!

Building Better With Our Greatest Resource...Education®

Course Description

This two-day, twelve-hour class describes and examines the requirements for a fire alarm system. The function and use of the different fire alarm system components will be investigated, which includes; fire alarm control panel, initiating devices, and alarm notification appliances.

Included in this survey will be determining how each component operates and how they work together to notify the building occupants of the emergency, as well as other related functions such as fan shut downs and monitoring of systems and devices.

BFCA

Learning Objectives / Learning Outcomes

Students successfully completing this course will be provided information and guidance in order to:

* Identify when the building and fire codes require fire alarm systems.
* When provided with a floor plan the student will analyze the plan for proper coverage for smoke detectors as well as proper coverage for alarm notification devices.
* Determine the spacing requirements for differing initiating devices.
* Identify fire alarm systems testing requirements

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

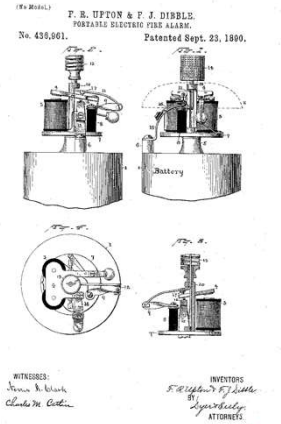
Building Better With Our Greatest Resource…Education®

BFCA

- History
  - Pre-mechanical / Electrical systems
    - Patrols
    - Watch and bell towers
  - First Fire Alarm System developed by Dr. William F. Channing & Moses Farmer
    - Fire Alarm Telegraph
    - City wide system in Boston
    - Went into use 1852

BFCA

* First Electrical Fire Alarm System first developed by Francis Robbins Upton and Fernando J. Dribble
  - 1890
  - A heat detector that utilized electric activation



BFCA

* First Smoke detector developed by Walter Jaeger
  - Late 1930s
  - While attempting to develop a poison gas sensor but found that his cigarette smoke was registered

BFCA

* Single Station alarms come to market 1960s
* Battery Powered Single Stations 1970
* First Standard for smoke alarms NFPA 74, last edition was 1989 before being incorporated into NFPA 72

BFCA

- What is the Purpose of a Fire Alarm System?

BFCA

- Question.
  - Purpose of a fire alarm system?

A Early Detection	B Notification
C Suppression Activation	D All of the above

- What is the Purpose of a Fire Alarm System?
  - Early detection
  - Alert and evacuate
  - Life Safety
  - Provide an automatic and/or manual means of alarm activation
  - Actuate fire suppression systems
  - Activate fire safety control functions
  - Notify emergency responders

BFCA

- General Abbreviations
  - FACU - Fire Alarm Control Unit
  - FACP - Fire Alarm Control Panel
  - SLC - Signaling Line Circuit
  - SD - Smoke Detector
  - HD - Heat Detector
  - IDC - Initiating Device Circuit

BFCA

* NAC - Notification Appliance Circuit
* NFPA - National Fire Protection Agency
* AHJ - Authority Having Jurisdiction
* LED - Light Emitting Diode

* EOL - End of Line Resistor
* NEC - National Electric Code
* Cd - Candela
* dB, dBA - Decibels
* ANSI - American National Standards Institute
* UL - Underwriters Laboratories
* SFPE - Society of Fire Protection Engineers
* Shall - Indicates a mandatory requirement
* Should - Indicates a recommendation / Advisement

- Abbreviations that not in common use add confusion
- Regionally - Terms can vary (local slang)

What Are the Parts of a Fire Alarm System?

- Fire alarm control panel
- Power supply
- Wiring system
- Initiating devices
- Signaling line circuits
- Manual and automatic features
- Notification appliances
- Notification circuits
- Building safety control circuits

Fixed Heat Detector

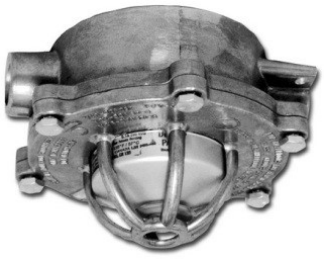
Fire Alarm Classifications

- Per NFPA 72
- Types of commercial fire alarm systems
  - Protected premises
  - Supervising station
  - Public emergency alarm

Smoke Detector

Protected Premises

- No communication ability with a monitoring facility
- Local alarms activated by
  - Smoke / Heat detectors
  - Water flow devices
  - Other initiating devices



Detector for Hazardous Environment

Protected Premises

- Serve the general fire alarm needs for the building or facility
- These are the core features that fire alarm systems are built on

Supervision Station

- There are 3 types of Supervisory Fire Alarm systems:
  - Central station service
  - Proprietary supervising station
  - Remote supervising station

Central Station Service

- Normally dictated by an insurance company
- Utilized in facilities that are:
  - High value
  - High hazard
- Highly specialized systems
- Connected to a listed Central Station operating company

Proprietary Station Fire Alarm Systems

- One ownership
- Single or multiple systems
- Common uses:
  - College campuses, airport, multiple building complexes, military bases, large corporations

- Remote Station
  - Most common type
  - Use a communicator or radio system to transmit signals
    - Listed central station
    - Non-listed monitoring facility
    - Depends on requirements of AHJ

BFCA

- Question.
  - A college campus with multiple buildings being monitored at one security office is an example:

A Central Station	B Proprietary Station
C Remote Station	

BFCA

- Question.
  - A building equipped with a fire alarm system and fire sprinkler system shall utilize what type(s) of monitoring:

A Central Station	B Proprietary Station
C Remote Station	D Any

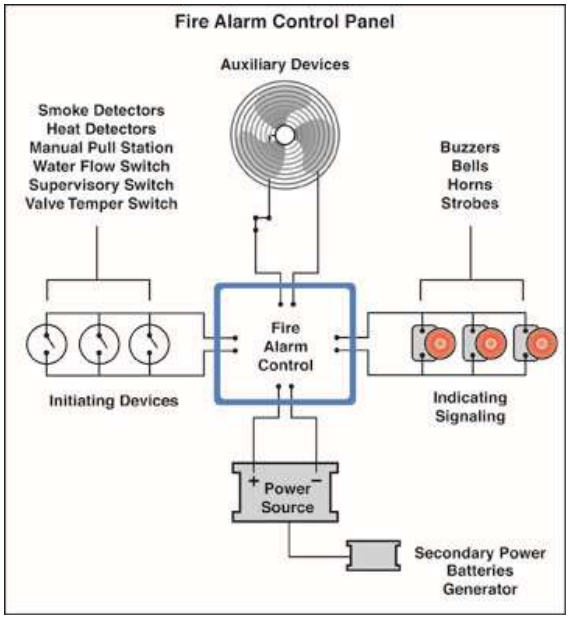
BFCA

- Public Emergency Alarm Reporting System (PEARS)
  - Also known as municipal fire alarm systems
  - A system of initiating devices, receiving equipment, and communication infrastructure (other than phone lines) used to transmit alarms to the public fire service communication center
  - Auxiliary fire alarm systems – are used to connect protected premises fire alarm system to a public fire alarm reporting system
  - Examples:
    - Site Emergency Call boxes

BFCA

FACP Parts

- Initiating
- Notification
- Auxiliary
- Power
- Circuiting



Function of Fire Alarm Control Panel

- Provides power to system components
- Monitors device inputs and controls outputs
- Modern panels have motherboards
- Notification
  - Notify occupants in all or certain parts of the building
  - Notify key building personnel
  - Notify fire department
- Outputs include activation of building control systems

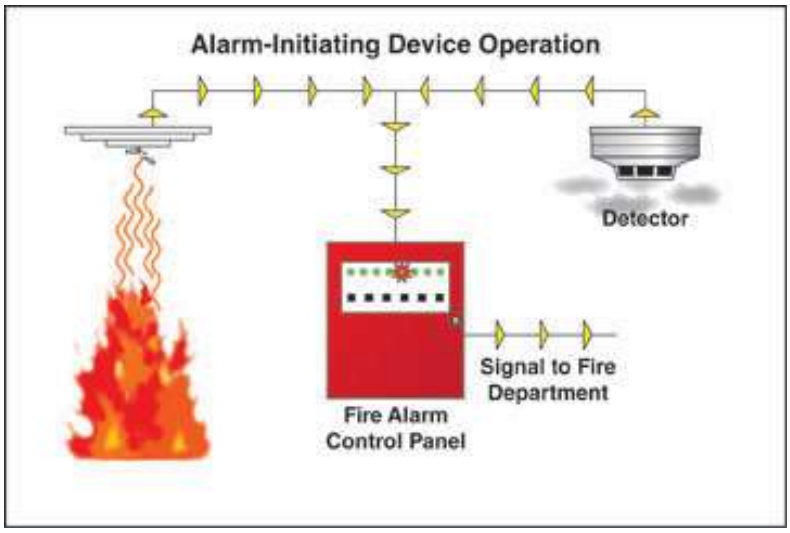
Fire Alarm System Inputs

- Initiating devices
  - Initiate transmission to control panel to indicate a change in condition
  - Signaling Line Circuits (SLC) is the circuit multiple initiating devices utilize

BFCA

- Initiating device types:
  - Manual fire alarm box
  - Smoke detector
  - Heat detector
  - Special detector
  - Monitor module

BFCA



BFCA

- Fire Alarm System Outputs
  - Notification appliances
    - Provides notification to building occupants
    - Signals how occupants react to emergency conditions
      - Evacuate
      - Partial evacuation
      - Protect in place

BFCA

* Notification appliance types
  - Horns
  - Strobes
  - Bells
  - Chimes
  - Voice or text display

* Notification Appliance Circuit (NAC)
  - The circuitry that powers and controls the notification appliances
  - Directly connected to notification devices
  - Supervised circuit
  - May be one or more pairs of conductors for each circuit

BFCA

- Auxiliary Devices
  - These include additional control features
  - The most common include:
    - Door Holds
    - Annunciators

BFCA

- Power
  - Primary Power (Normal Power)
  - Secondary Power (Backup Power)

- Wiring
  - Requirements covered by
    National Electrical Code (NEC / NFPA 70) and the
    National Fire Alarm Signaling Code (NFPA 72)

- Wiring

BFCA

- Types of Fire Alarm Systems
  - Conventional systems
  - Intelligent

BFCA

- Conventional Systems
  - Older design
  - Still being produced
  - Becoming less popular
  - Display only Normal, Trouble, Supervisory, and Fire
  - Will not indicate specific device or location

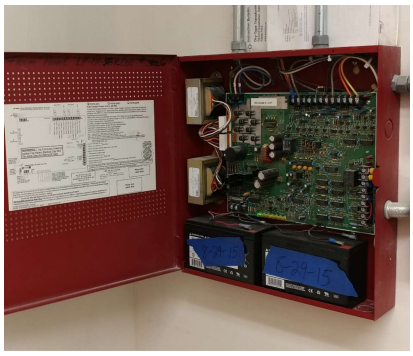
BFCA

- Requires devices be inspected visually to determine activation
- Precautionary note: Older systems may not be non-power limited systems, which are energized with 120 volt or be of a DC voltage no longer supported

BFCA

- Intelligent Fire Alarm Systems
  - Also known as Addressable Fire Alarm Systems
  - Each device communicates individual status back to the fire alarm control panel
  - Each device address (location) indicates initiating device type and has a description
  - Addressable notification appliances

BFCA



BFCA

- Question.
  - Does the code and standards permit the use of a new conventional fire alarm system?

A Yes	B No

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Determining Fire Alarm Code Requirements

Building Better With Our Greatest Resource...Education®

BFCA

Codes That Dictate Design

- National Fire Alarm Code NFPA 72
- International Fire Code (IFC)
- International Building Code (IBC)
- Life Safety Code NFPA 101

BFCA

Where are Fire Alarm Systems Required?

- The requirements are primarily contained in the Building and Fire Code Section 907
- Other chapters including Chapters 4, 5, and 10 in the International Building Code will also influence the design of the fire alarm system
- Choices made by the design professional or building owner unrelated to Chapter 9 may significantly impact the design

BFCA

- Question.
  - Is full detection required in all occupancies?

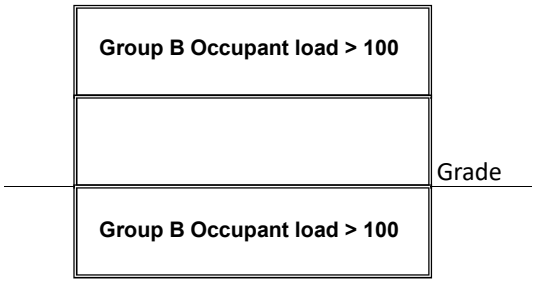
A Always	B Majority
C Sometimes	D Never

BFCA

- Group A 907.2.1
  - Manual alarms in Group A with an occupant load > 300
    - Pull stations not required when equipped with a fire sprinkler system, notification under water flow
  - When 100 or more persons located above or below lowest level of exit discharge
  - Group A with occupant load > 1000 requires Emergency Voice alarm with an emergency power system
    - Note the Life Safety Code reduces the occupant load to 300 persons
  - Stadiums, arenas, and grandstands require captions 907.5.2.2.4

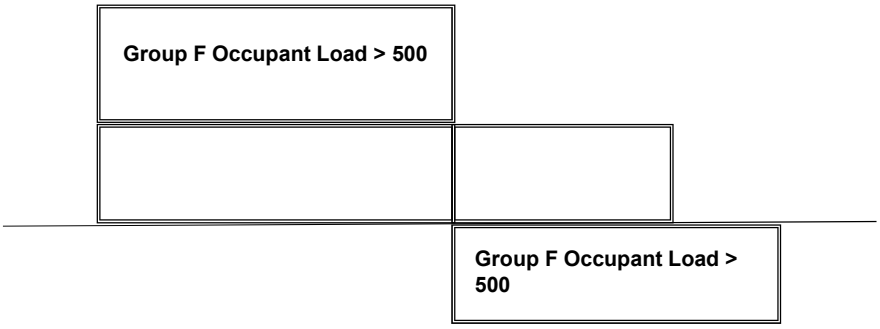
BFCA

* Group B 907.2.2
  - Group B Manual alarm requirements with a combined occupant of 500 or more unless sprinklered with alarm notification on a water flow
  - Contains an ambulatory health care facility
  - Smoke detection system required in ambulatory health care facility unless sprinklered with occupant notification



* Group E 907.2.3
  - Shall be connected to the fire alarm system
  - Emergency/voice alarm
  - Exceptions:
    - Manual fire alarm system not applicable for occupant loads < 50
    - Emergency voice not required if occupant load is 100 or less
    - Fire alarm boxes not required if equipped with smoke detection or fire sprinkler (exceptions 3 & 4)

* Group F 907.2.4
  - Combined load > 500 & two or more stories



Manual fire alarm box exemption for sprinklered buildings with notification.

BFCA

* Group H 907.2.5
  - Manual alarms required in:
    - All Group H-5
    - Manufacture of organic coatings
  - Automatic smoke detection required when
    - Highly toxic gases
    - Organic peroxides
    - Oxidizers

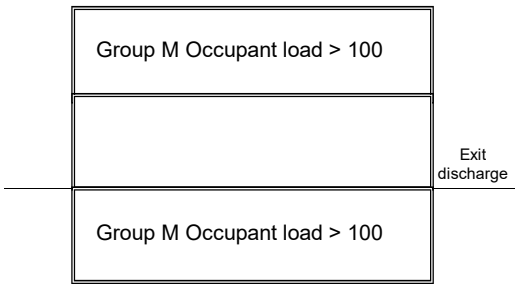
BFCA

* Group I 907.2.6
  - All Group I
    - Manual fire alarm
    - Automatic fire alarm system
  - Group I-1
    - Manual alarms – not at exits if at care provider station and visible
    - Smoke detection in corridors, habitable spaces and waiting rooms
    - Not in habitable spaces if sprinklered

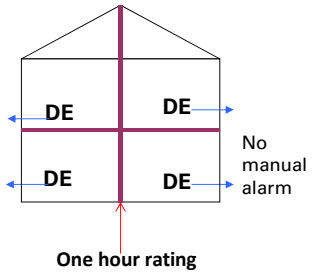
* Group I 907.2.6.2
  - Group I-2
    - Manual alarms, not at exits if at care provider station and visible
    - Automatic fire detection required in corridors and/or spaces open to the corridors based on the I-2 Condition 1 or Condition 2
    - Hospitals smoke detection per 407

* Group I 907.2.6.3
  - Group I-3
    - Manual alarm system
    - Automatic smoke detection system in some areas
    - Exception to location of manual pull systems
    - Smoke control system

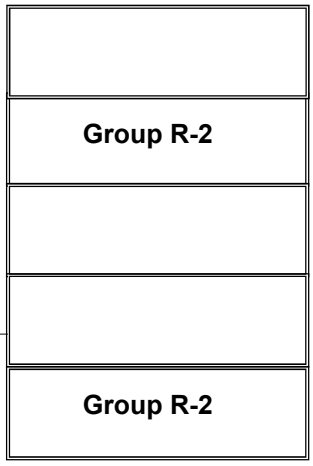
* Group M 907.2.7
  - Combined occupant load > 500
  - Group M manual alarm requirements unless sprinklered with alarm notification on a water flow
  - Note: when occupied, alarm notification not required when signal is sent to constantly attended location to manually initiate notification



* Group R-1 907.2.8
  - Manual alarm
  - Automatic smoke detection system throughout interior corridors serving sleeping units
  - No manual alarm if an NFPA 13 or 13R sprinkler system
    - Occupant notification upon activation
    - One manual pull for testing



* Group R-2 907.2.9.3
  - Manual alarm required when one of the following is met
    - three or more stories above lowest level of discharge
    - one level below
    - more than 16 dwelling units
  - Automatic smoke detection for colleges and universities
  - Single and multiple smoke detectors per 907.2.11

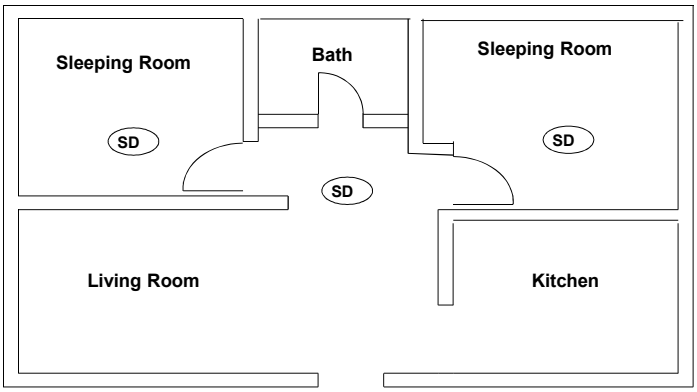


* Group R-4 907.2.10
  - Manual fire alarm system that activates occupant notification system shall be installed
  - Occupancies three stories or greater in height for interior corridors and interior common areas
    - Not required when building is sprinklered throughout and occupant notification is activated with water flow

* Single and multiple station smoke alarms 907.2.11
  - Where required 907.2.11.1
    - Group R-1
    - In each story including basements

On each level if multiple levels

* Where required Groups R-2, R-3, R-4, I-1 907.2.11.2
  - In each story including basements



- Per code and NFPA 72 for households
- 110 volt with battery back-up
- Emit low battery alarm
- Interconnected
- Tested
- Listed per UL 217

- Other Features That Require a Fire Alarm System
  - Special amusement buildings - 907.2.12
  - High rise buildings - 907.2.13
  - Atriums - 907.2.14
  - High piled combustible storage areas - 907.2.15
  - Aerosol storage areas - 907.2.16
  - Lumber, wood structural panel and veneer mills - 907.2.17
  - Underground buildings with smoke control - 907.2.18

BFCA

- Deep underground buildings - 907.2.19
- Covered mall buildings - 907.2.20
- Residential aircraft hangers - 907.2.21
- Airport traffic control towers - 907.2.22
- Energy storage systems - 907.2.23

BFCA

- Egress Design (IBC 1005.3.1)
- Emergency Alarm Systems (Group H Occupancies) 908
- Smoke Control Systems 909
- Carbon Monoxide Systems 915
- Gas Detection Systems 916
- Mass Notification Systems 917

BFCA

- Fire Sprinkler Systems 903.4

BFCA

- Question.
  - Which code / standard determine the fire alarm design requirements?

A IBC/IFC	B NFPA 72
C NFPA 70	D All of the Above

- Question.
  - Are all the requirements for the fire alarm design detailed in Chapter 9 of the International Building and Fire Code?

A YES	B NO

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Fire Safety Functions

Building Better With Our Greatest Resource...Education®

BFCA

- Fire Alarm Fire Safety Functions 907.3
  - Automatic fire detectors connected to FACP
  - Detectors perform intended function and activate
  - Activate visible and audible supervisory signal
  - Duct smoke detectors connected to FACP
  - Delayed egress locks connected
  - Detectors for elevators connected per ASME A17.1 & NFPA 72
  - Smoke detector at FACU 907.4.1
    - Substitute heat detector based on environment

BFCA

BFCA

BFCA®

Building & Fire Code Academy

Understanding Fire Alarm Basics

Fire Alarm Control Panel Functions

Building Better With Our Greatest Resource...Education®

BFCA

Fire Alarm Control Panel Power Requirements

- Requires two power sources (AC/DC)
- Primary power typically 120V converted to low voltage energy (NFPA 72)
  - Marked in red
  - Identified “Fire Alarm Circuit”
  - Over current protection allowed – sized for the load
- Secondary power (DC) provides power when primary down
  - Lasts for minimum 24-hours (standby)
  - Minimum 5 minutes of alarm or 15 minutes voice alarm activation

BFCA

- Must be calculated
- Batteries rated in amp hours
  - Permanently marked with month and year of manufacture
  - Recharged within 48-hours
- Generators can be used
  - 10 second load pick up
  - Not affect the system performance

BFCA

Fire Alarm Signals

- Alarm
- Trouble
- Supervisory

Trouble Alarm Signals

- A signal initiated by the system or device indicative of a fault in a monitored circuit, system, or component
  - Loss of primary power
  - Low DC battery condition
  - Ground fault condition
    - System or wiring

* Separate distinct signal
  - An opening in a monitored circuit
  - Loss of audio amplifier, tone generator
  - Short in a NAC
  - Loss of any connection in the circuits

BFCA

Supervisory Alarm Signals

* Indicate presence of change in system status or function
  - Low-pressure alarm on dry system riser
  - Tamper switch activation
  - Fire pump running
  - Low temperature alarm
  - Duct smoke detector activation

BFCA

Fire Alarm Signals

- Indicates activation of initiating device
  - Smoke or heat detector
  - Activated suppression system
    - Kitchen hood or halon system
  - Activated water flow device
  - Activated manual pull station

BFCA

Coded and Non-Coded Systems

- Non-coded – alarm continuously transmitted
- Zoned non-codes – indicates indication of a zone or area
- Voice alarm – notification devices are speakers
  - Indicate the activation of an initiating device

BFCA

Supplementary Controls

- Door holding devices
- Fan shut down
- Equipment shut down
- Elevator recall
- Damper control
- Extinguishing system interface
- Security system interface

Remote Annunciation

- May be required by AHJ when FACP location not readily located
  - Provided when required by the AHJ
  - Typically placed in vestibule or other point of entry
  - Displays source/location of activated device
  - Acts as duplicate FACP

Model 5635


EXIT
FIRE

- Question.
  - Visual Occupant Notification is required?

A Work Areas	B Public & Common Areas
C Public	**D** All of the Above

BFCA

- Occupant Notification 907.5
  - Visual Notification Requirements
    - Public & common areas
    - Special occupancy requirements
  - Auditory Notification Requirements
    - Entire building that is habitable

BFCA

* Annunciate at panel
* Activate occupant notification
* Activated by initiating devices
  - (Automatic fire detectors / Sprinkler water flow)
  - Manual fire alarm boxes / Automatic fire extinguishing system
* Pre signal if allowed by the fire code official

* Audible alarms
  - Distinctive alarm used for no other purpose
  - 15 decibels above normal ambient sound or
  - 5 decibels above the maximum sound level
  - Every occupiable space
  - Private / sleeping areas have additional requirements

- Minimum sound level
  - R-1 and R-2 audible alarm shall be a 520-Hz low frequency signal

    Can be provided by a smoke detector with an integral 520-Hz sounder
  - 75 dBA in I-1
  - 90 dBA in mechanical rooms
  - 60 dBA in other occupancies
  - Maximum 110 dBA

    Where average ambient noise is greater than 105 dBA, visible alarm notification per NFPA 72

BFCA

* Emergency voice / alarm communication system 907.5.2.2 is required:
  - Malls > 50,000 square feet
  - High rise buildings
  - Underground Buildings
  - Group A with occupant load > 1,000
  - Group M per 907.2.7.1
  - Special amusement building
  - Mezzanines 505.1

BFCA

- Atriums
- Smoke control
- Mezzanines 505.2
- Deep underground buildings
- Specific egress designs

- Linked to automatic fire detection, sprinkler water device or manual fire alarm system
- Speakers throughout building in paging zones
  - Elevator groups
  - Exit stairways
  - Each floor
  - Area of refuge as defined in Section 1002.1
- Installed per NFPA 72
- General or staged evacuation

- Manual override required
- Live voice message capabilities
- Can be used for other announcements

* Visual Notification

* Visual alarms location
  - Not in alterations unless system is upgraded
  - Not in exits
  - Not in elevator cars
  - Provide in public and common areas
  - If in employee work areas – maximum 20% over design for growth
  - Group I-1 and R-1 per Table 907.5.2.3.2
  - Group R-2 dwelling and sleeping units per ICC A117.1

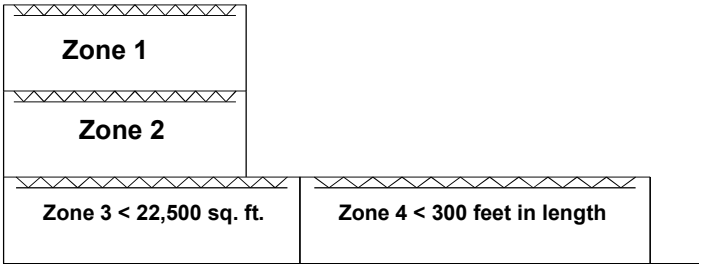
BFCA

Installation – 907.6

* Per NFPA 72
* Wiring per NFPA 70 and 72
* Power supply per NFPA 72

BFCA

* Zones 907.6.4



* Zone indicator panel and controls in approved location
  - Monitored by approved supervising station
  - Telephone dialers not connected to FD telephone number

BFCA

♦ Testing 907.7

* All systems and equipment tested
* Operating, testing and maintenance instructions provided
* As built drawings provided

BFCA

- Maintenance 907.8
  - Maintenance and testing schedule and procedure per the IFC

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Emergency Alarm Systems

Building Better With Our Greatest Resource...Education®

BFCA

- Emergency Alarms 908
  - Detection of emergency conditions
  - Notification of emergency condition
  - Group H occupancies
    - Per section 415.5

  - Required
    - Group H-5 908.2
    - Facilities with toxic and highly toxic materials 908.3


EXIT

BFCA

BFCA®

Building & Fire Code Academy

Understanding Fire Alarm Basics

Carbon Monoxide Detection

Building Better With Our Greatest Resource...Education®

BFCA

- Carbon Monoxide Detection 915
  - CO detection required in the following occupancies
    - I-1
    - I-2
    - I-4
    - R Occupancies
    - E Occupancies
    - Dwelling units with fuel burning appliances
    - Private garages
    - Note there are multiple exemptions

BFCA

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Gas Detection Systems

Building Better With Our Greatest Resource…Education®

BFCA

- Gas Detection 916
  - Gas detection where required per IBC/IFC
    - Examples include car repair faculties serving lighter the fuel vehicles
  - Emergency or standby power required
  - Sensors installed where gases are expected to accumulate
  - Gas sampling rate based on gas type

BFCA

* System activation
  - Flammable gases 25% of lower flammability limit (LFL)
  - Non-flammable 50% Immediate danger to life and health (IDLH) threshold

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Mass Notification Systems

Building Better With Our Greatest Resource...Education®

BFCA

- College and University Campuses 917
  - Prior to construction of a new building with occupant load of 1,000 or more
  - Mass notification risk analysis performed per NFPA 72
  - If indicated, an approved mass notification system shall be provided

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Local Amendments

Building Better With Our Greatest Resource...Education®

BFCA

- Local Amendments (Ohio)
  - The Building Official shall have the authority over fire alarm systems with input from the Fire Chief
  - R-2 college and university buildings
    - Owned or operated (Ohio 907.2.9.3)
  - Notification Requirements
    - Meets NFPA 72, Chapter 11, ICC A117.1 (Ohio 907.5.2)

BFCA

SS1

- Local Amendments (Ohio)
  - System Alterations
    - Visual alarm notification appliances are not required in alterations, except where, as part of the alteration, an existing notification appliance is relocated, and existing fire alarm system is upgraded or replaced, or a new fire alarm system is installed. (Ohio 907.5.2.3 Exemption 1)
  - Initiating Device identification
    - Required systems shall by addressable (Ohio 907.6.3)
- Local Rules
  - Outside Notification
  - Site or Project Specific Requirements

BFCA

Slide 122

SS1 Do we need to add something for Local Rules? Its just kinda hanging...
Sonya Shearer, 6/19/2018

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Signal Initiation and Initiation Components

Building Better With Our Greatest Resource…Education®

BFCA

- Initiation Devices
  - Automatic and manual
  - Signal other equipment
  - Accessible location
  - Protected from mechanical damage
  - Supported independently
  - Maintained
  - Installed throughout entire building

BFCA

* Not required
  - Combustible blind spaces
  - Below open grid ceilings
  - Concealed accessible spaces above a suspended ceiling
  - Open loading dock and platforms
  - Partial systems when allowed by the applicable code
  - Non-required coverage – installed per code except spacing

* Fire signatures are what a fire produces
  - Dynamic forms can be used to identify the fire
    - Products of combustion particles
    - Heat – Thermal energy
    - Gases
    - Radiant energy
    - Smoke

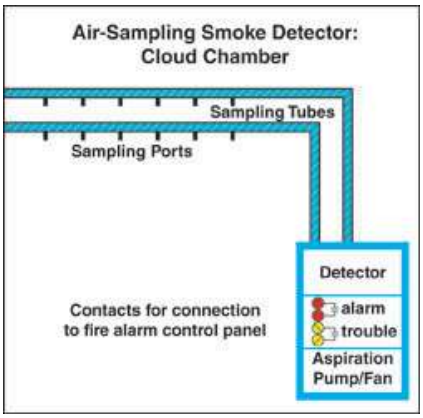
* Automatic fire detectors
  - Designed to detect common signatures of combustion at early stages
  - Structural environment must be considered for proper design/placement may produce or mimic signatures
  - Best to use detectors immune to environmental factors

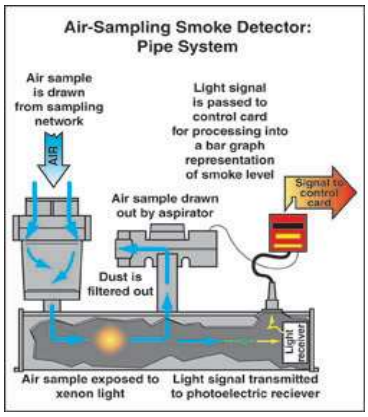
* Most common Automatic fire detectors
  - Photoelectric
    - Light scattering
    - Light obscuration
  - Ionization
  - Thermal / Heat
  - Duct

- Spot detection
  - Concentration in a particular spot
  - Smoke and heat detectors

Rate Compensation Detector

- Air sampling
  - Draws air from protected area using perforated piping
  - Cannot identify fire source
  - Can protect large areas (up to 20,000 square feet)
  - Can be used in high air flow areas
  - Trade names – Vesda, AnaLaser





BFCA

- Line detection
  - Network of detectors along linear path
  - More cost effective over large area
  - Trade names - Pneumatic, Cable (Protectowire), Project Beam Detectors

BFCA

- Thermal energy / Heat detection
  - Detects energy released by change in products of combustion
  - Provide fewer false activations than other types
  - Thermal layering caused by fire can be detrimental to use because of time
  - Oldest type of automatic detector
  - Least expensive and most reliable
  - Slowest to respond
  - Thermal lag – delay in time from fire initial stages to reach air around detector
  - Best used where fast developing fire expected or where other types of detection not suitable

BFCA

- Fixed temperature detectors
  - Respond when temperature at detector reaches predetermined specific level
  - Various temperature ratings available (135º – 200º most common)
  - Restorable and non-restorable types

    Restorable reset after temperature falls

    Non-restorable must be replaced after use

BFCA

- Line type heat detection
  - Provides heat detection over linear path
  - Various types available
  - One type used two conductor wires separated by heat sensitive insulation
  - After alarm activated section must be identified and replaced

BFCA

- Rate of rise detectors
  - Activates when temperature rises more than 15º per minute
  - Usually employ a fixed temperature element in addition to a flexible diaphragm in a chamber
  - Rate of rise element is self-restorable
  - Fixed temperature element not restorable

BFCA

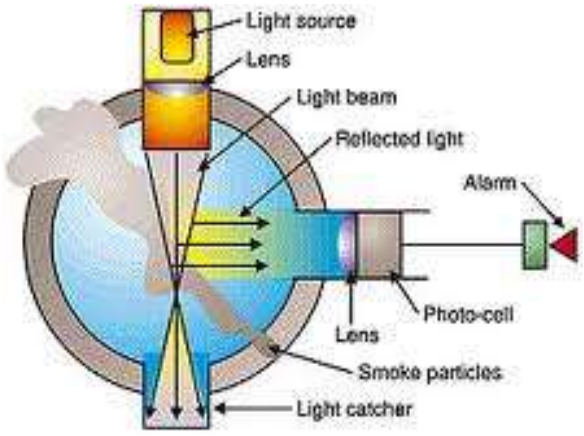
- Rate compensation heat detectors
  - Detector responds when area reached a pre-determined level regardless of the rate of rise
  - System compensates for thermal lag
  - Unit has tubular metal case extending lengthwise when heated resulting in the extension to pull on contacts allowing them to close
  - Entire unit must reach the target temperature to be activated

- Thermoelectric effect detectors
  - Commonly known as Thermistor detectors
  - Uses sensing elements to produce an increase in voltage in response to temp rise
  - Monitored by signal processing equipment to detect rapid rise in voltage
  - Circuitry may have capability to send actual temperature data to alarm panel
  - Provides capability of fixed temperature, rate of rise or both
  - Can also be incorporated into smoke detectors

- Photoelectric detectors
  - Provides a more rapid response than heat detectors
  - Uses LED to send beam of light into dark chamber striking a photo diode on the opposite side in the chamber
  - Two types

    Light scattering

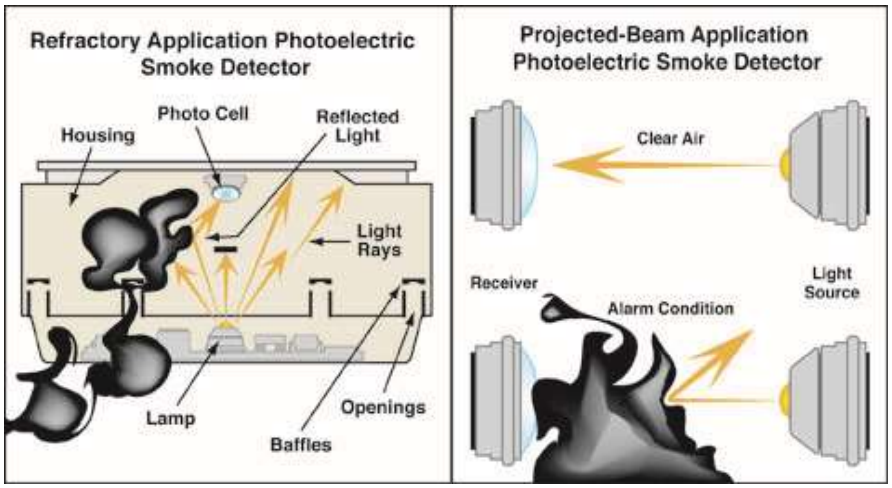
    Light obscuration



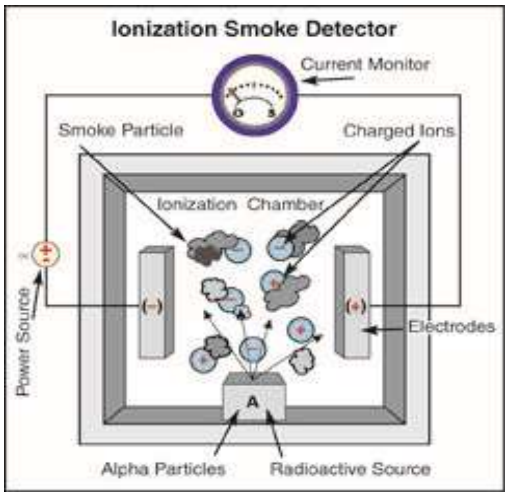
Photoelectric Method

- Light scattering
  - Most common
  - Smoke particles enter chamber deflecting a portion of the light rays into photocell
  - Photocell generates a current when exposed to light
  - When current reaches predetermined level the alarm activates

- Light obscuration
  - Common with projected beam detectors
  - Project light from transmitter to receiver
  - If receiver loses sight of transmitter in short amount of time alarm activates
  - Over time malfunctions occur because of buildup of dirt and dust



- Ionization smoke detectors
  - Use small amount of radioactive material
  - Minute amount not dangerous
  - Radiation develops a low, steady electrical current
  - Smoke particles entering chamber disrupt current resulting in activation
  - Modern detectors have dual chambers, second chamber acts as a reference – protected from smoke particles but senses atmospheric changes
  - React faster to incipient fires



- Duct smoke detectors
  - Photoelectric detector mounted in housing outside ductwork with probes extending into duct to sample air
  - Purpose to prevent spread of smoke via the HVAC system
  - Designed to detect fire within the HVAC system or to detect smoke drawn into system from rooms
  - Not for replacement of primary fire detection
  - Detectors must be rated to handle the air velocity of specific HVAC unit

* Specialty devices
  - Gas detectors
    - Designed to detect gases from specific materials where products of combustion are normally present in high levels
  - Flame detectors
    - Visual sensing devices that look for Ultraviolet or Infrared emitting source in a normally lighted environment
    - Normally requires more than one wavelength of either UV or IR or both to cause an alarm
  - Spark / Ember detectors
    - Visual sensing devices that look for Ultraviolet (UV) or Infrared (IR) sources in normally darkened environment
    - Light sources may cause a false alarm

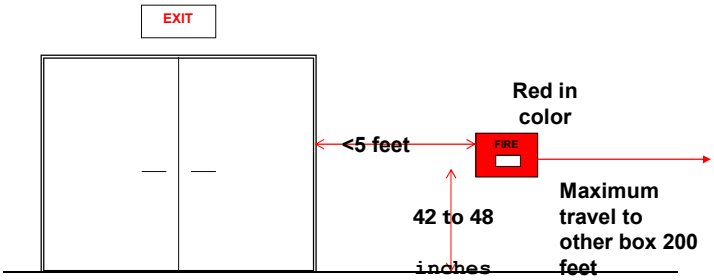
* Manual initiating devices
  - Commonly referred to as pull stations
  - Used to manually initiate alarm signal
  - Single and Dual Action – refers to physical action required to activate manual station
  - May have key locks or hex key locks
  - Multiple language / Dual language available
  - Conventional or addressable

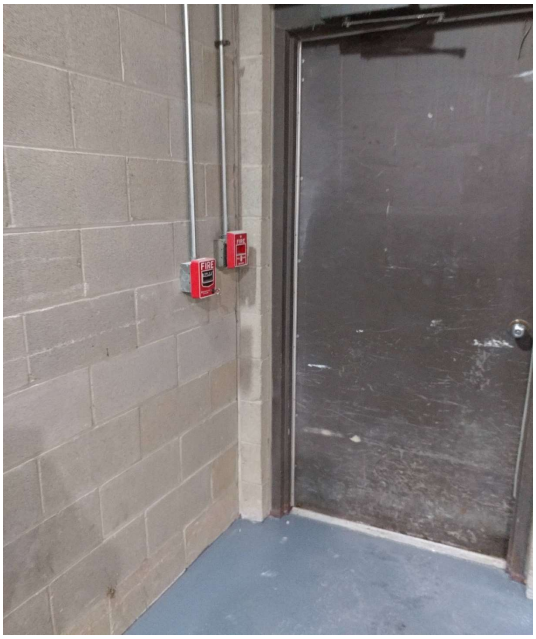
BFCA

- Provide a minimum of one manual pull station
  - Functions as a test initiating device

BFCA

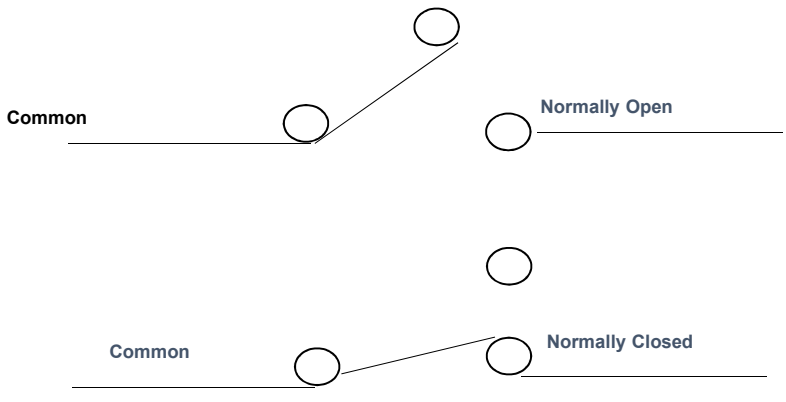
* Manual alarm requirements 907.4.2
  - Signs if not a monitored system





- Other initiating devices
  - Water flow switches
  - Alternate suppression systems
- Relays and controls
  - Used in various functions as part of system
    - Damper / Fan shutdown
    - Elevator recall
    - Door release
  - Configured on a fixed basis
    - Alarm / Trouble
    - Can be programmed to be activated under specific input conditions

* Relays used to initiate control of fire safety function
  - Must be located within 3’ of the controlled circuit or appliance
  - When relay not active contacts are in normal positions
  - Monitor modules used to monitor status of conditions such as sprinkler valves and water flow devices



When the relay is activated, current passes through the relay coil the common “wiper”, moving it to the opposite position.

- Fire Suppression and Fire Alarm Systems
  - Sprinkler systems
    - Wet system
      - Uses vane activated water-flow device
      - Reacts to changes in water pressure of 10 psi
      - Represents flow equivalent to one head activating
      - Uses retard device to inhibit false activations from pressure changes on supply side

BFCA

- Dry system
  - Filled with air monitored by air pressure switch
  - Water entering system causes change in pressure activating the switch resulting in alarm

BFCA

- Pre-action system
  - Charged with air under pressure
  - Valve prevents water from entering piping
  - Fire alarm system uses smoke detectors quicker response than sprinkler heads
  - When SD activates valve allows water to fill piping
  - Used to prevent water damage

- Deluge system
  - Automatic system where all heads open
  - Water held back at main valve
  - Trigger device typically smoke or heat detection
  - Used where water must be applied quickly due to hazard
    - Aircraft hanger
    - Hazardous material storage

* Water flow devices
  - Designed to detect a drop in pressure equivalent to one sprinkler head opened and report alarm condition
  - Each riser requires one water flow device
  - Maximum of five water flow switches connected to single initiating device circuit
  - Water flow devices required to activate in 90 seconds of operation
  - Delay required to prevent false alarms
    - Waste
    - Surges
    - Variances in pressure

BFCA

♦ Sprinkler System Monitoring

* Valve supervision
  - Valves control water from water source
  - Must be monitored by tamper switch
  - Closing valves trigger monitoring device and activates supervisory alarm
  - Most common types:
    - PIV
    - Butterfly
    - OS&Y

BFCA

* Supervisory devices
  - System for off-normal conditions that may effect proper operation of system
    - Fire pumps
    - Pressure tanks
    - Room temperature
    - Water temperature
    - Valve position

* Water level
  - Water in gravity tank monitored by float level device
  - Typically a 3” or more change in level activates supervisory signal
* Water temperature
  - Monitors temperature of water to prevent freezing
  - Usually temps below 40º results in activated supervisory alarm

* Air Pressure
  - Used in dry system
  - Monitors low and high air pressure conditions
  - Usually 10 psi above or below normal

* Room temperature device
  - Usually used with wet pipe systems
  - Monitors alerts to a decrease in temperature to predetermined level
  - Supervisory alarm usually activates at 40º
* Fire pumps
  - Monitors power condition
  - Phase reversal
  - Pump running
  - Failure to start

- Question.
  - Ionization smoke detectors utilize what method of detection?

A Radiation & change in charge	B Blockage of light

- Question.
  - Which sprinkler systems require electronic monitoring?

A NFPA 13	B NFPA 13R
C NFPA 13D	D Both A&B

- Question.
  - Automatic smoke detection is required per the IBC, what detectors can I use?

A Ionization detector	B Beam
C Photoelectric detector	D All

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Circuits and Pathways

Building Better With Our Greatest Resource...Education®

BFCA

- System Wiring Types
  - Per NFPA 72 12.3 pathways or circuit types are defined by the following classes:
    - Class A
    - Class B
    - Class C
    - Class D
    - Class E
    - Class N
    - Class X

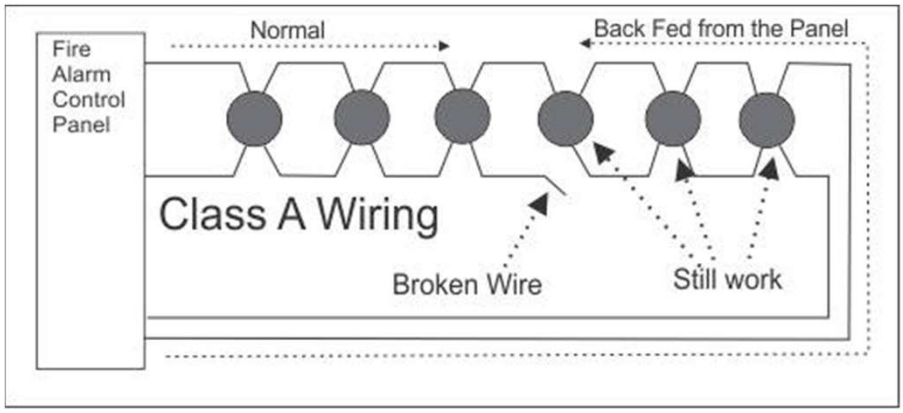
BFCA

- Question.
  - What are the most common types of circuits for fire alarm systems?

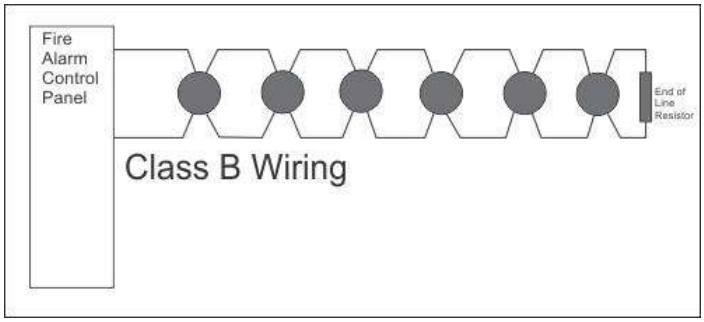
A Class A	B Class B
C Class C	D Class D

BFCA

* Class A
  - Redundant path
  - Allows alarm and supervisory signals to continue to operate with single open or ground fault on any circuit conductor
  - Required by certain job specifications or by insurance authorities to provide higher degree of system reliability



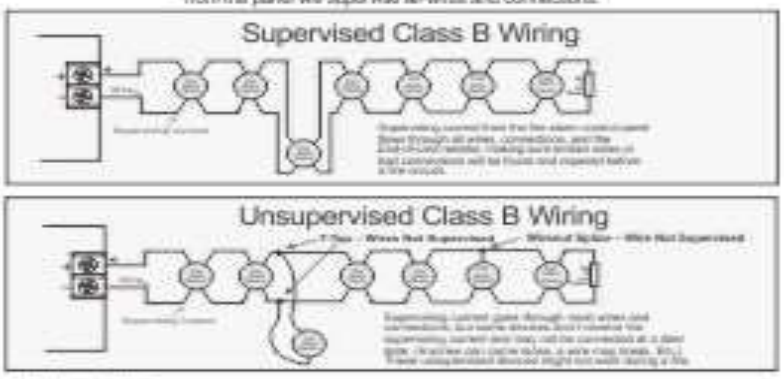
* Class B
  - Most common
  - Allows alarm and supervisory to be transmitted or notification signals to continue to operate between the control panel and location of the single open or ground fault
  - Are at end of line resister (EOL) supervised
  - Do not have a return path to the control panel
  - No redundancy



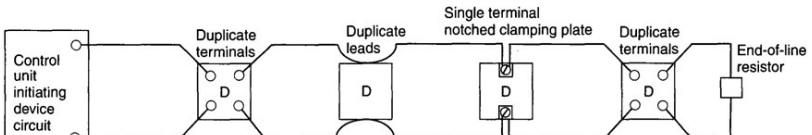
Fire Alarm System

Class B Wiring

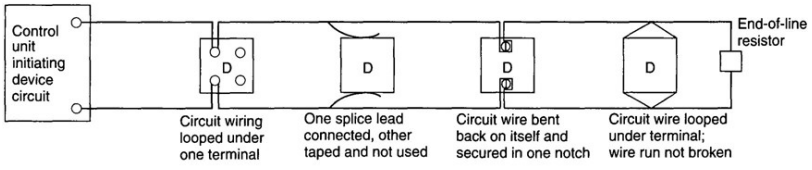
All fire alarm wiring needs to be installed so that a current from the panel will supervise all wires and connections.



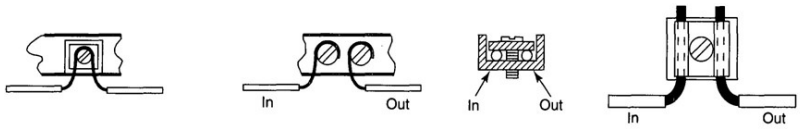
BFCA



Correct wiring method — two-wire detectors



Incorrect wiring method — two-wire detectors



Incorrect **Correct — separate incoming and outgoing conductors**

BFCA

* Class C
  - End to end communication with confirmation and annunciation
  - “Handshake”
  - Some digital monitoring
  - LAN, WAN, Internet

* Class D
  - Fails safe
  - Not supervised
  - Examples include door closers that release under loss of power

* Class E
  - Not monitored for integrity
  - Examples
    – Listed equipment in the same enclosure
    – Trouble notification circuit

* Class N
  - New in 2016
  - Includes two or more paths (primary and redundant)
  - End to end communication
  - Signal loss annunciated
  - Ethernet

* Class X
  - Redundant path
  - Capable of operating after certain faults
  - Isolation modules are typically utilized

BFCA

Pathway Survivability NFPA 72 12.4

* The level of protection provided to a circuit via combinations of rated cables, rated enclosures, rated systems, sprinkler protection or performance alternatives
* Higher levels require greater protection from fire exposure
* Multiple Levels
  - Level 0
  - Level 1
  - Level 2
  - Level 3

BFCA

* Level 0 NFPA 72 12.4.1
  - No additional requirements

* Level 1 NFPA 72 12.4.2
  - Building is fully protected by an automatic sprinkler system in accordance with NFPA 13
  - Conductors, cables, circuits in metal raceways

* Level 2 NFPA 72 12.4.3
  - At least one of the following
    - 2-hour fire rated circuit integrity (CI) or fire resistive cable
    - 2-hour fire rated cable system
    - 2-hour fire rated enclosure or protected area
    - Performance alternatives approved by the AHJ

* Level 3 NFPA 72 12.4.4
  - Building is fully protected by an automatic sprinkler system in accordance with NFPA 13
  - And at least one of the following
    - 2-hour fire rated circuit integrity (CI) or fire resistive cable
    - 2-hour fire rated cable system
    - 2-hour fire rated enclosure or protected area
    - Performance alternatives approved by the AHJ

- Shared Pathway Designations
  - Determines priority of life safety vs non-life safety data
  - Multiple Levels
    - Level 0
    - Level 1
    - Level 2
    - Level 3

BFCA

  - Level 0 NFPA 72 12.5.1
    - Not required to be segregated

BFCA

* Level 1 NFPA 72 12.5.2
  - Segregation not required for life safety vs non-life safety data
  - Shall prioritize all life-safety data

* Level 2 NFPA 72 12.5.3
  - Segregate life safety vs non-life safety data

* Level 3 NFPA 72 12.5.4
  - Dedicated life safety equipment

BFCA

Nomenclature NFPA 72 12.7

* A way to identify the required properties of a system and shall include:
  - System(s) interconnections
  - Survivability levels – not required if Level 0
  - Shared Pathway Levels – not required if Level 0
* Examples:
  - A
  - B.3

BFCA

Electrical Code Requirements

- National Electrical Code NFPA 70
- National Electrical Code Article 760
  - Power limited
    - Power supply / Transformer
    - Typically DC 20-100V 100VA
    - FACP to devices
  - Non-power limited
    - Circuit can operate up to 600V and power output is not limited
    - Certain bell // horn // motor control // elevator etc.

BFCA

Wiring Types

- THHN - Thermoplastic High Heat-resistant Nylon-coated
- FPL – Fire Alarm Cable
- FPLR – Fire Alarm Cable Riser
- FPLP – Plenum Fire Alarm Cable

BFCA

BFCA

- Power and Electrical Concerns
  - Signaling line circuits carry multiple device signaling typically for addressable systems
  - Notification circuits
  - Parallel circuits
    - Used for strobes, horns, bells, speakers
    - NAC (Notification Alarm Circuits panels) can be added to extend circuit
      - Requires separate battery, monitoring, smoke detector

BFCA

* FACP power supplies
  - Must have own dedicated branch circuit to primary source
    - Usually commercial electric company
    - Usually single 120V connection wired directly to low voltage transformer in FACU

- Dedicated branch circuit primary FACP power must be protected from damage
- Circuit breaker must be marked in red designating it as a FIRE ALARM Circuit
- Must be in a protected breaker box
- Box may be in a locked room or have lock on it to protect from unauthorized access
- Dedicated circuit must have over current protection capable of handling maximum short circuit

* Secondary power
  - Must provide backup power within 10 seconds of loss of power
  - Usually rechargeable storage batteries of the sealed lead acid type
  - Batteries are recharged and monitored by FACP
  - NFPA 72 requires batteries to provide 24-hours standby power and 5 minutes of alarm
  - 24-hours and 4 minutes for household systems
  - Systems for voice evacuation must provide 24-hours of standby and 15 minutes in alarm at maximum load

BFCA

- For 12V system single battery permitted
- For 24V two batteries required (in series)
- Some requirements may require 4 batteries
- Each set of two must be wired in parallel to increase amperage and the two sets must be wired in series to increase voltage
- System must provide large enough charger to fully recharge batteries within 48-hours

BFCA

- Once recharged must be maintained at full charge and protected from overcharging
- Charger must be supervised and able to initiate a trouble signal in the event of charger or battery failure
- Engine driven generators may be used for secondary power but must be auto starting
  - Control panel must have sufficient batteries to provide 4 hours of standby time in case generator does not start

* Battery calculations
  - Voltage drop
    - Ensuring the end of line voltage exceeds the minimum voltage
  - Battery calculations (FACP & NAC)
    - Standby
    - Alarm
  - These items are checked in plan review

* Fire safety functions
  - F/A systems often designed to work in conjunction with other building systems
    - Elevators
    - Exit doors
    - Smoke management
    - Lighting
    - HVAC Systems
    - Dampers

- Control of fire safety functions may be achieved with use of electronic safety relay module
- Modules must be placed within 3’ of the device its controlling
- If relays or appliances operate on loss of power they are considered supervised

* Combination systems
  - Systems may share
    - Circuitry
    - Equipment components
    - Wiring with non-fire alarm systems

- Non-fire systems may not interfere with operation of the F/A system
- Open circuits, ground fault conditions, short circuits shall not interfere with monitoring for integrity of system
- May not compromise any
  - Alarm activation
  - Supervisory activation
  - Fire safety control signal transmissions

- AHJ can require separate display or annunciator if the non-fire alarm info displayed is excessive or confusing
- Signals from carbon monoxide detectors shall be permitted to be transmitted as supervisory signals

* Elevator recall
  - Requirements for fire alarms established by ANSI/ASME A 17.1 (Safety Code for Elevators and Escalators)
  - System detectors used for elevator recall must be connected to the building FACU
  - Smoke detectors not installed in elevator hoistways unless required to activate smoke relief equipment

- If hoistway is protected by sprinkler system a heat detector with lower temperature rating than the sprinkler head required within 2’ to shunt power to elevator prior to activation
- Hoistway and machine room detectors must indicate separate and distinct visible indicator at control unit or annunciator
  - Alerts suppression crews that elevator is not safe to use

- Each group of elevators requires a minimum of three circuits be wired back to the controller
- Elevator power shunted before sprinklers operate
- Heat detector is placed within two feet of the sprinkler and have a lower temperature

* HVAC systems
  - Duct smoke detectors may transmit supervisory or alarm signal
  - Remote indicators installed in location approved by AHJ shall indicate activation via steady LED light
    - Typically mounted next to control panel or at eye level below the duct detector
    - Indicator must be located to associated HVAC unit
    - Should be displayed accordingly at control panel

BFCA

- Duct detection required on supply side of HVAC systems over 2,000 cfm downstream of air filters and ahead of any branch connections
  - NFPA 90A requires systems more than 15,000 cfm and serving more than one story require detector at each story
  - Return system detectors not required if space is protected by area smoke detectors
  - International Mechanical Code 606.2 states duct detectors not required where air distribution systems are incapable of spreading smoke beyond enclosing walls, floors or ceilings of room in which the smoke is generated

BFCA

* Door release
  - Smoke detectors may provide door release from magnetic holders upon activation
  - Access control and electronic door locking systems must be connected to the fire alarm system
    – All exits connected to the system must unlock upon activation of the fire alarm signal or loss of primary power to the fire alarm system

* Smoke control
  - Mechanical ventilation systems and pressurized stairwell systems can be activated by smoke detectors or water flow switches
* Emergency shutoff
  - Solenoid or mechanically operated valves shutoff gas or liquid fuel supplies to the building when the alarm is activated

- Question.
  - When is firefighter recall for an elevator required?

A All New	B New over 25ft travel
C Existing over 25ft travel	D A & C

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Article 760

Building Better With Our Greatest Resource...Education®

BFCA

- Article 760 – Fire Alarm Systems
  - 760.1 Scope. This article covers the installation of wiring and equipment of fire alarm systems, including all circuits controlled and powered by the fire alarm system.

- 760.133 / 760.135 cabling installation requirements
- Ducts Specifically Fabricated for Environmental Air
  - FPLP & FPLP-CI
  - FPLP, FPLP-CI, FPLR, FPLR-CI, FPL, and FPI-CI in approved raceways
- Plenums
  - FPLP & FPLP-CI
  - FPLR & FPL approved metal raceways

* Risers based on vertical run, raceway and shaft

(D) Risers — Cables in Vertical Runs. The following cables shall be permitted in vertical runs penetrating one or more floors and in vertical runs in a shaft:

(1) Types FPLP and FPLR cables
(2) Types FPLP and FPLR cables installed in the following:
   a. Plenum communications raceways
   b. Plenum cable routing assemblies
   c. Riser communications raceways
   d. Riser cable routing assemblies

Informational Note: See 300.21 for firestop requirements for floor penetrations.

BFCA

(E) Risers — Cables in Metal Raceways. The following cables shall be permitted in metal raceways in a riser having firestops at each floor:

(1) Types FPLP, FPLR, and FPL cables
(2) Types FPLP, FPLR, and FPL cables installed in the following:
   a. Plenum communications raceways
   b. Riser communications raceways
   c. General-purpose communications raceways

Informational Note: See 300.21 for firestop requirements for floor penetrations.

BFCA

(F) Risers — Cables in Fireproof Shafts. The following cables shall be permitted to be installed in fireproof riser shafts having firestops at each floor:

(1) Types FPLP, FPLR, and FPL cables
(2) Types FPLP, FPLR, and FPL cables installed in the following:

a. Plenum communications raceways
b. Plenum cable routing assemblies
c. Riser communications raceways
d. Riser cable routing assemblies
e. General-purpose communications raceways
f. General-purpose cable routing assemblies

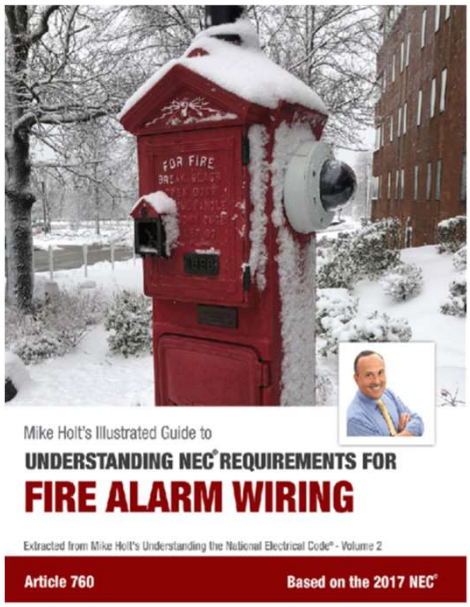
Informational Note: See 300.21 for firestop requirements for floor penetrations.

BFCA

Table 760.154 Applications of Listed PLFA Cables in Buildings

Applications		Cable Type		
		FPLP & FPLP-CI	FPLR & FPLR-CI	FPL & FPL-CI
In fabricated ducts as described in 300.22(B)	In fabricated ducts	Y*	N	N
	In metal raceway that complies with 300.22(B)	Y*	Y*	Y*
In other spaces used for environmental air as described in 300.22(C)	In other spaces used for environmental air	Y*	N	N
	In metal raceway that complies with 300.22(C)	Y*	Y*	Y*
	In plenum communications raceways	Y*	N	N
	In plenum cable routing assemblies	Y*	N	N
	Supported by open metal cable trays	Y*	N	N
	Supported by solid bottom metal cable trays with solid metal covers	Y*	Y*	Y*
In risers	In vertical runs	Y*	Y*	N
	In metal raceways	Y*	Y*	Y*
	In fireproof shafts	Y*	Y*	Y*
	In plenum communications raceways	Y*	Y*	N
	In plenum cable routing assemblies	Y*	Y*	N
	In riser communications raceways	Y*	Y*	N
	In riser cable routing assemblies	Y*	Y*	N
	In one- and two-family dwellings	Y*	Y*	Y*
Within buildings in other than air-handling spaces and risers	General	Y*	Y*	Y*
	Supported by cable trays	Y*	Y*	Y*
	In any raceway recognized in Chapter 3	Y*	Y*	Y*
	In plenum communications raceway	Y*	Y*	Y*
	In plenum cable routing assemblies	Y*	Y*	Y*
	In riser communications raceways	Y*	Y*	Y*
	In riser cable routing assemblies	Y*	Y*	Y*
	In general-purpose communications raceways	Y*	Y*	Y*
	In general-purpose cable routing assemblies	Y*	Y*	Y*

BFCA



Mike Holt's Illustrated Guide to

UNDERSTANDING NEC® REQUIREMENTS FOR

FIRE ALARM WIRING

Extracted from Mike Holt's Understanding the National Electrical Code® - Volume 2

Article 760 **Based on the 2017 NEC®**

BFCA

* Separation of power-limited fire alarm with other conducts
* Mechanical protection
* Enclosures

BFCA

Table 760.179(I) Cable Markings

Cable Marking	Type
FPLP	Power-limited fire alarm plenum cable
FPLR	Power-limited fire alarm riser cable
FPL	Power-limited fire alarm cable

Note: Cables identified in 760.179(D), (E), and (F) as meeting the requirements for circuit integrity shall have the additional classification using the suffix "CI" (for example, FPLP-CI, FPLR-CI, and FPL-CI).

Informational Note: Cable types are listed in descending order of fire resistance rating.

BFCA

BFCA®

Building & Fire Code Academy

Understanding Fire Alarm Basics

Detector Spacing

Building Better With Our Greatest Resource...Education®

BFCA

Fire Alarm Key Definitions

- Fire alarm system
  - As defined by IFC
  - System or potion of combination system
  - Consists of components and circuits
  - Arranged to monitor and annunciate the status of a fire alarm or supervisory self-initiating device
  - Initiates the appropriate response to those signals

- Beam ceiling
  - Solid projections down from surface
  - More than 4”
  - 3’ apart
- Solid joist ceiling
  - Solid projections down from surface
  - More than 4”
  - 3’ or less apart to center

* Sloped ceiling
  - Ceiling with slope of more than 1’ rise or fall every 8’
* Peaked ceiling
  - Ceiling with slopes in more than one direction from the highest point in a peaked ceiling
  - Curved or dome ceilings are considered peaked with the slope figured as a chord from the highest to the lowest point

BFCA

♦ Heat Detectors

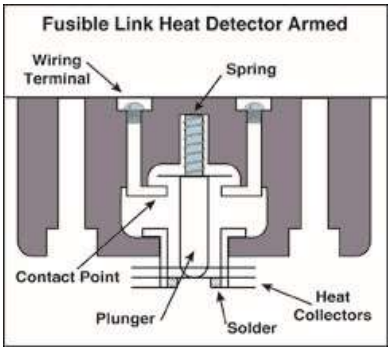
BFCA

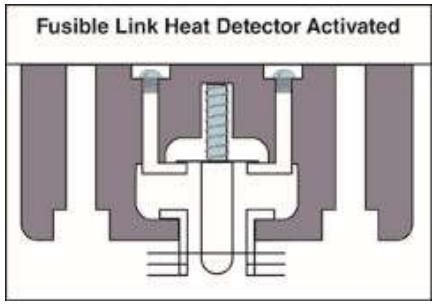
* Temperatures per Table 17.6.2.1
* 20° higher than the table

Table 17.6.2.1 Temperature Classification and Color Code for Heat-Sensing Fire Detectors

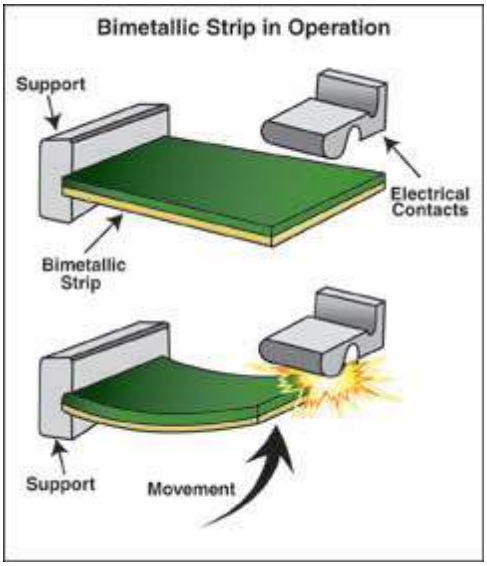
Temperature Classification	Temperature Rating Range		Maximum Ceiling Temperature		Color Code
	°F	°C	°F	°C	
Low	100–134	38–56	80	28	Uncolored
Ordinary	135–174	57–79	115	47	Uncolored
Intermediate	175–249	80–121	155	69	White
High	250–324	122–162	230	111	Blue
Extra high	325–399	163–204	305	152	Red
Very extra high	400–499	205–259	380	194	Green
Ultra high	500–575	260–302	480	249	Orange

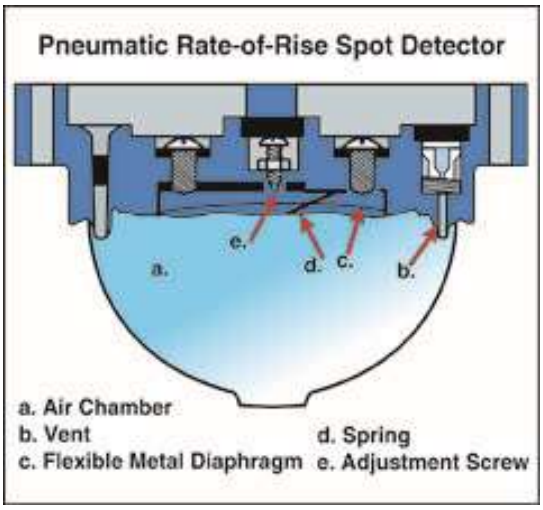
BFCA

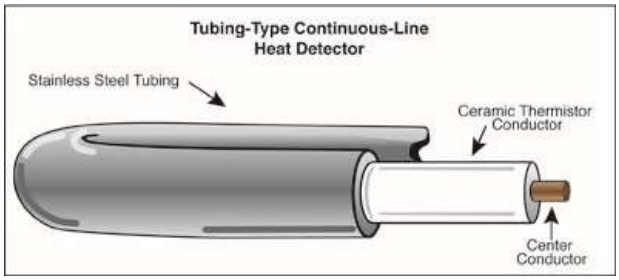


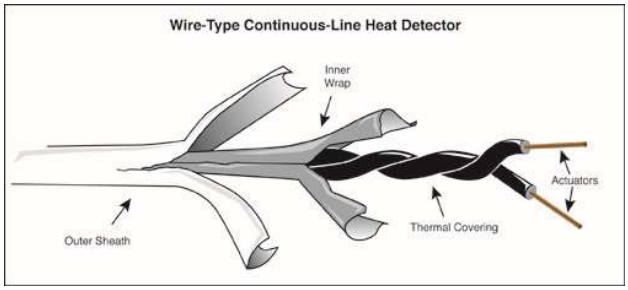


BFCA


Bimetallic Strip in Operation
Support
Electrical Contacts
Bimetallic Strip
Support
Movement

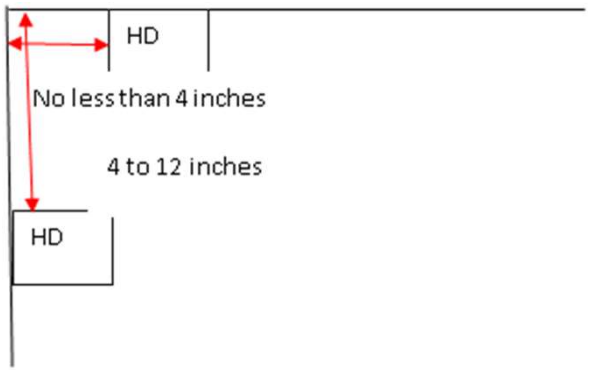

Pneumatic Rate-of-Rise Spot Detector
e.
d.
c.
b.
a.
a. Air Chamber
b. Vent
c. Flexible Metal Diaphragm
d. Spring
e. Adjustment Screw





BFCA

* Location
  - On ceiling no less than 4” from the side wall
  - On the wall 4” to 12” from ceiling



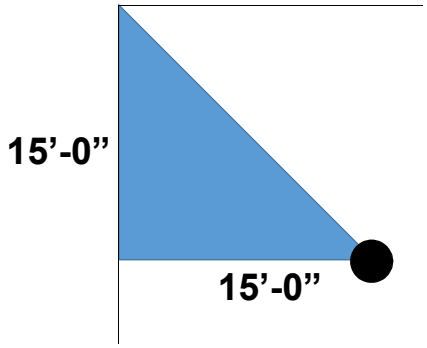
BFCA

* Solid joist – bottom of joist
* Beams
  - Less than 12” in depth
  - Less than 8” on center
  - Bottom of joist
  - Considered as a smooth ceiling if beams project less than 4”

* Location – line type of detectors
  - On ceiling
  - On side wall no greater than 20” down
  - Solid joist bottom of joist
  - Beams
    – Less than 12” in depth
    – Less than 8’ on center
    – Bottom of joists

* Spacing
  - Per manufacturer – typically 30’ to 50’
  - Maximum 1/2 the spacing at right angles to the wall
  - Distance to irregular shapes 0.7 x spacing

* Spacing
  - .7 spacing
  - $A^2 + B^2 = C^2$
  - $15^2 + 15^2 = C^2$
  - $225 + 225 = C^2$
  - $500 = C^2$
  - $22.3 = C$
  - $30 * .7 = 21$



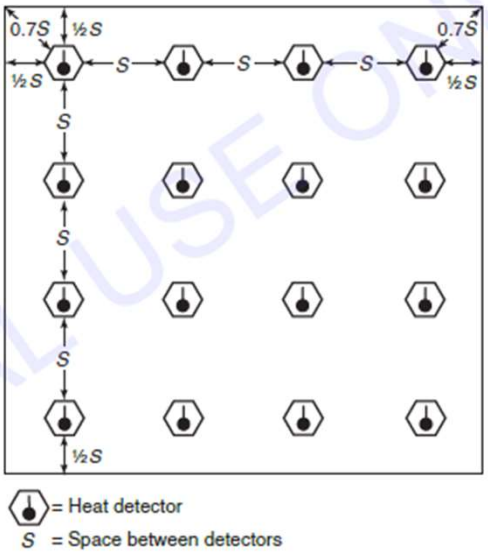


FIGURE A.17.6.3.1.1(a) Spot-Type Heat Detectors.

BFCA

* High ceiling greater than 10' – Table 17.6.3.5.1

Table 17.6.3.5.1 Heat Detector Spacing Reduction Based on Ceiling Height

Ceiling Height Greater than (>)		Up to and Including		Multiply Listed Spacing by
ft	m	ft	m	
0	0	10	3.0	1.00
10	3.0	12	3.7	0.91
12	3.7	14	4.3	0.84
14	4.3	16	4.9	0.77
16	4.9	18	5.5	0.71
18	5.5	20	6.1	0.64
20	6.1	22	6.7	0.58
22	6.7	24	7.3	0.52
24	7.3	26	7.9	0.46
26	7.9	28	8.5	0.40
28	8.5	30	9.1	0.34

BFCA

Ceiling Height Above	Up to and Including	Multiply Listed Spacing By
10ft	12ft	0.91
12ft	14ft	0.84
14ft	16ft	0.77
16ft	18ft	0.58
18ft	20ft	0.74
20ft	22ft	0.58
22ft	24ft	0.52
24ft	26ft	0.46
26ft	28ft	0.40
28ft	30ft	0.34

BFCA

* Heat detectors on solid joist ceilings
  - Spacing to be reduced by 1/2 measured perpendicular to the joists
  - Detectors must be mounted on the bottom of the beams

BFCA

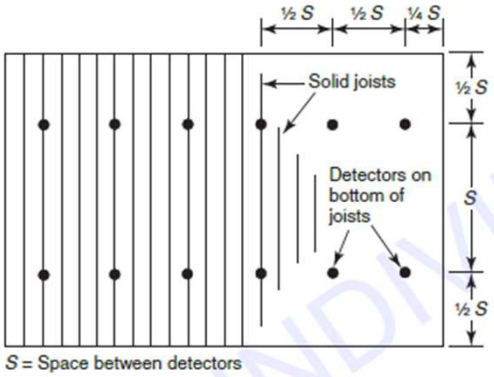


FIGURE A.17.6.3.2 Detector Spacing Layout, Solid Joist Construction.

BFCA

* Heat detectors on beam ceilings
  - Where beams are less than 12” deep and less than 8’ apart detectors must be mounted of bottom of beams
  - Beams more than 4” below ceiling require heat detector spacing be reduced by 2/3 the listed spacing perpendicular to the beam
  - Beam construction extending more than 18” below the ceiling and has beams more than 8’ apart requires each bay formed by the beams be treated as a separate bay

BFCA

* Peaked ceilings
  - Requires row of detectors placed within 3’ of the peak
  - Additional detectors spaced according to the horizontal distance to the ceiling and the ceiling construction

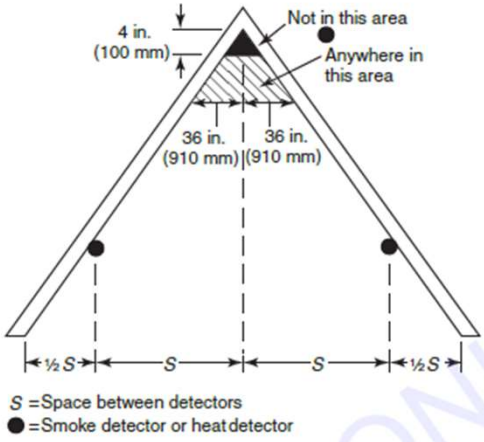


FIGURE A.17.6.3.4(a) Smoke or Heat Detector Spacing Layout, Sloped Ceilings (Peaked Type).

* Shed ceilings
  - Require row of detectors be placed within 3’ of the high side
  - Additional detectors spaced according to the horizontal distance of the ceiling and the ceiling construction

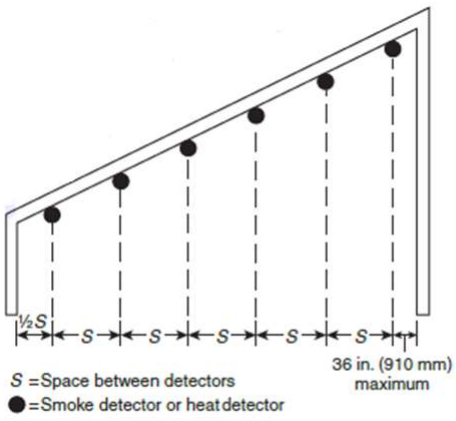


FIGURE A.17.6.3.4(b) Smoke or Heat Detector Spacing Layout, Sloped Ceilings (Shed Type).

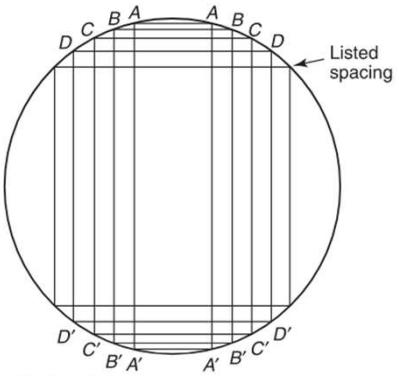
* Sloped roofs
  - Less than 30º spacing bead on height at peak of ceiling
  - With a slope of more than 30º detectors mounted based on average height of ceiling
    – Determine highest and lowest peaks and divide by 2

BFCA

* Quick Reference Roof Slope (vertical rise/horizontal run)
  - 1/2 4.46º
  - 2/12 9.46º
  - 3/12 14.04º
  - 4/12 18.43º
  - 5/12 22.62º
  - 6/12 26.57º
  - 7/12 30.26º

BFCA

- 8/12 33.69º
- 9/12 36.86º
- 10/12 39.81º
- 11/12 42.51º
- 12/12 45.00º



Rectangles

A = 10 ft × 41 ft = 410 ft^2 (3.1 m × 12.5 m = 38 m^2)
B = 15 ft × 39 ft = 585 ft^2 (4.6 m × 11.9 m = 54 m^2)
C = 20 ft × 37 ft = 740 ft^2 (6.1 m × 11.3 m = 69 m^2)
D = 25 ft × 34 ft = 850 ft^2 (7.6 m × 10.4 m = 79 m^2)

Listed spacing for heat detectors only = 30 ft × 30 ft = 900 ft^2 (9.1 m × 9.1 m = 84 m^2)

Note: Smoke detectors are not listed for spacing. Use manufacturer's coverage recommendations and this figure.

FIGURE A.17.6.3.1.1(g) Detector Spacing, Rectangular Areas.

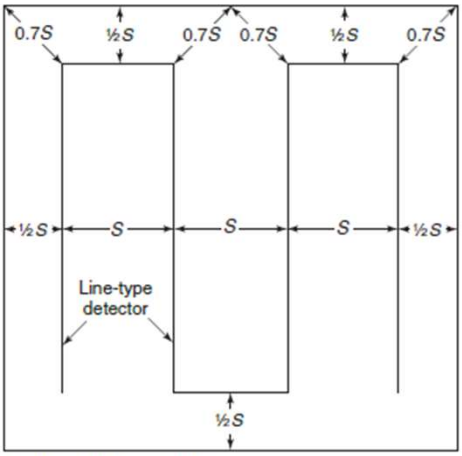


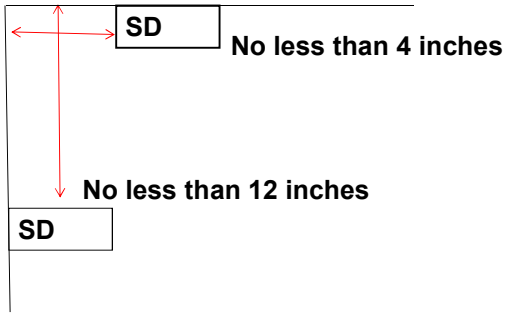
FIGURE A.17.6.3.1.1(b) Line-Type Detectors — Spacing Layouts, Smooth Ceiling.

BFCA

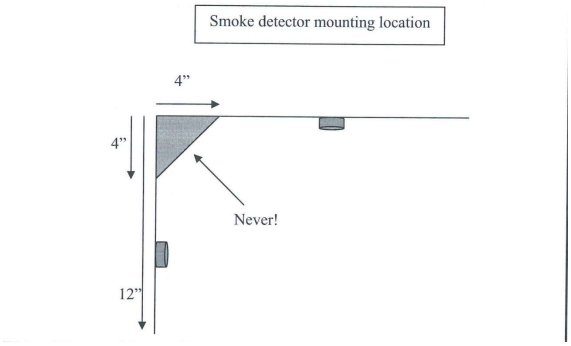
- Smoke Detectors
  - Prescriptively per this chapter – ordinary indoor locations
  - Performance options
  - For smoke control options
  - Limitations
    - 32º to 100º
    - Humidity below 93%
    - Air velocity less than 300'/minute
  - Not installed until all construction complete

BFCA

- Smoke Detectors
  - Location

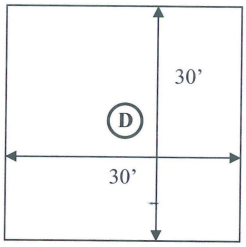


- Smoke Detectors
  - Spacing on ceilings
    - On smooth flat ceilings
    - Spaced on 30’ centers (unless manufacturer specifies differently)



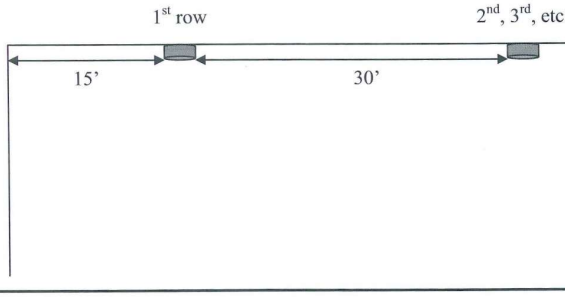
- Smoke Detectors
  - Spacing on ceilings
    - Spacing 30’ x 30’ or per the manufacturer
    - First row 1/2 the spacing from the wall

Smoke detector spacing

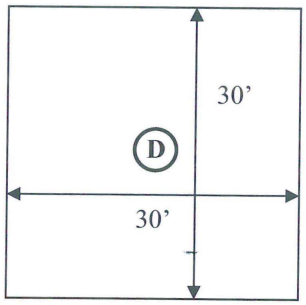


On smooth flat ceilings, the first row of smoke detectors must be located within ½ the spacing of the sidewall. Each consecutive row is located based on the spacing.

Smoke detector spacing – side view



Smoke detector spacing



BFCA

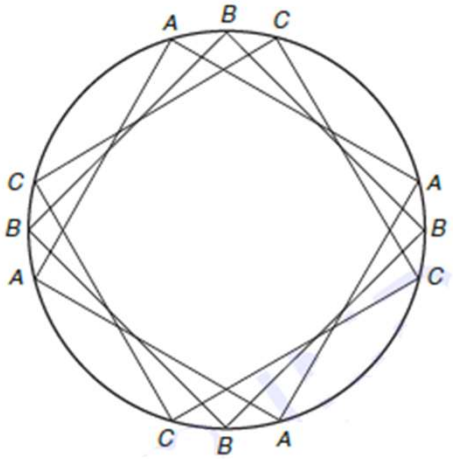
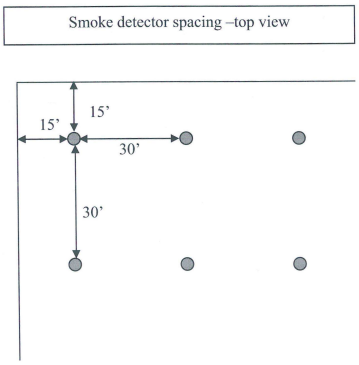


FIGURE A.17.6.3.1.1(d) Detector Covering any Square Laid Out in Confines of Circle in Which Radius Is 0.7 Times Listed Spacing.

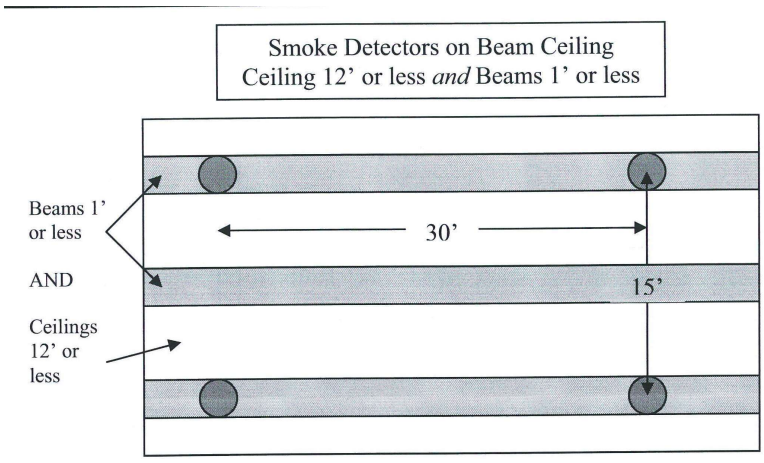
BFCA



Normal 30' spacing can be used in direction parallel to the beams provided the ceiling is 12' or less and the beam depth is 1' or less.

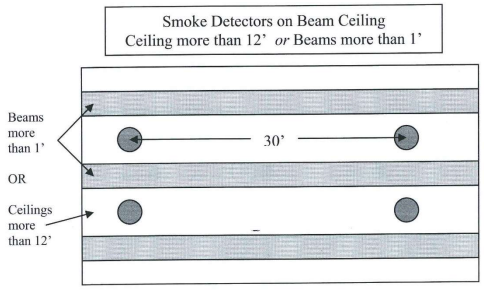
Spacing must be reduced by 1/2 in direction perpendicular to beam

BFCA



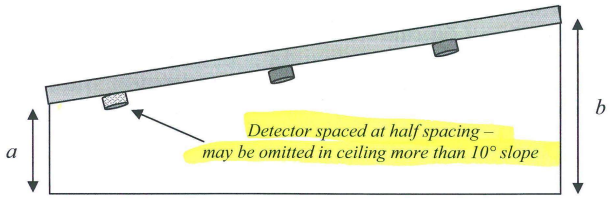
BFCA

- When ceiling heights exceed 12’ or beam depths exceed 1’ detectors are required to be mounted on the ceiling in every beam pocket



BFCA

Smoke detectors on sloped ceilings with beams running parallel to slope)

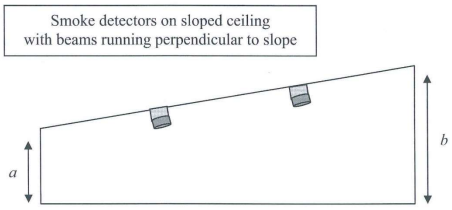


Diagram, NTC, d5.54

$$\text{Ceiling height} = \frac{a + b}{2}$$

BFCA

- Solid joists are considered equivalent to beams for smoke detector spacing considerations
- Sloped ceilings with joists detectors must be mounted on bottom of joist



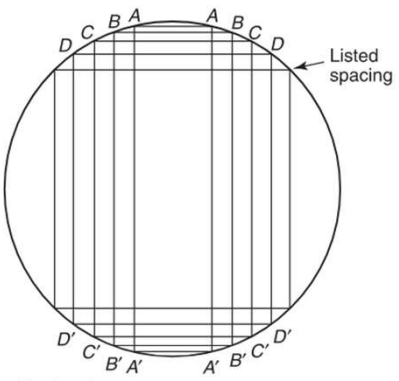
agram, NTC, d5.55

$$\text{Ceiling height} = \frac{a+b}{2}$$

- The 0.7 Rule
  - No point on ceiling is more than 0.7 times the listed spacing from a detector
  - Has practical applications in corridors
  - Corridors are narrow – NFPA 72 allows extended spacing of auto detectors

- Standard smoke detector spacing may be 30’ between detectors
  - One detector permitted to protect a room (30’ x 30’)
  - Detector located in the center of room 15’ from each sidewall
  - Every point in room is protected
  - Effective protection as much as 21’ away

- Corridors or narrow spaces
  - Corridor defined by ICC as enclosed exit access component that defines a patch of egress to an exit
    - 10’ wide corridor Extended spacing 41’
    - 15’ wide corridor Extended spacing 39’
    - 20’ wide corridor Extended spacing 37’
    - 25’ wide corridor Extended spacing 34’



Rectangles

A = 10 ft × 41 ft = 410 ft^2 (3.1 m × 12.5 m = 38 m^2)
B = 15 ft × 39 ft = 585 ft^2 (4.6 m × 11.9 m = 54 m^2)
C = 20 ft × 37 ft = 740 ft^2 (6.1 m × 11.3 m = 69 m^2)
D = 25 ft × 34 ft = 850 ft^2 (7.6 m × 10.4 m = 79 m^2)

Listed spacing for heat detectors only = 30 ft × 30 ft = 900 ft^2 (9.1 m × 9.1 m = 84 m^2)

Note: Smoke detectors are not listed for spacing. Use manufacturer's coverage recommendations and this figure.

FIGURE A.17.6.3.1.1(g) Detector Spacing, Rectangular Areas.

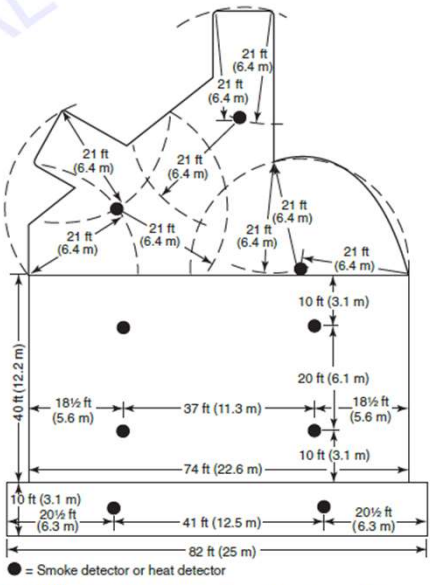
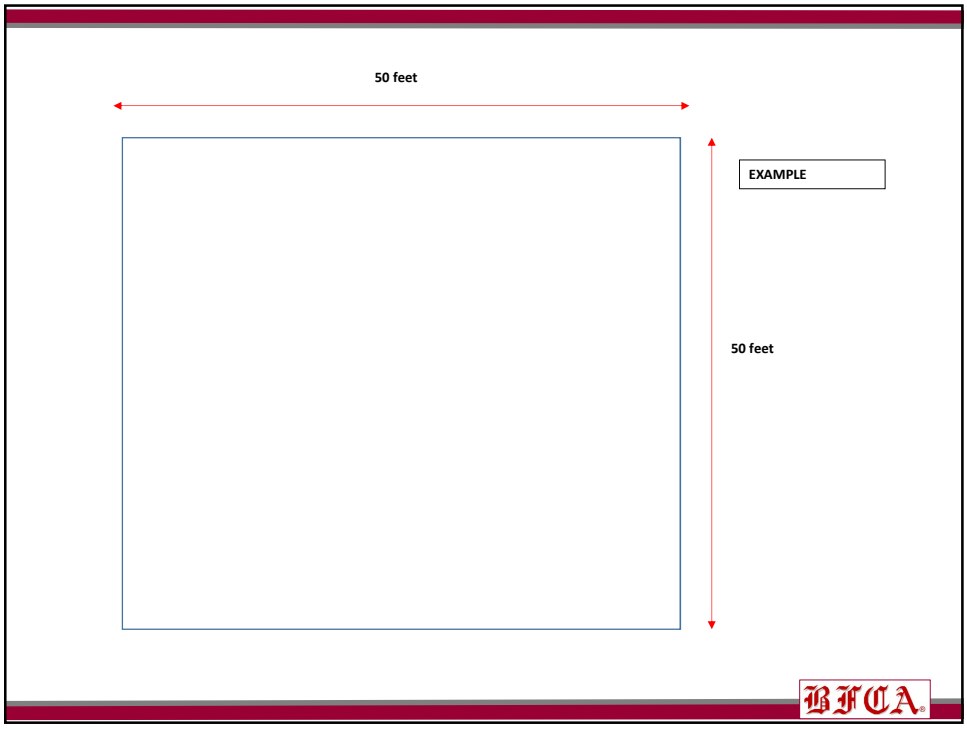
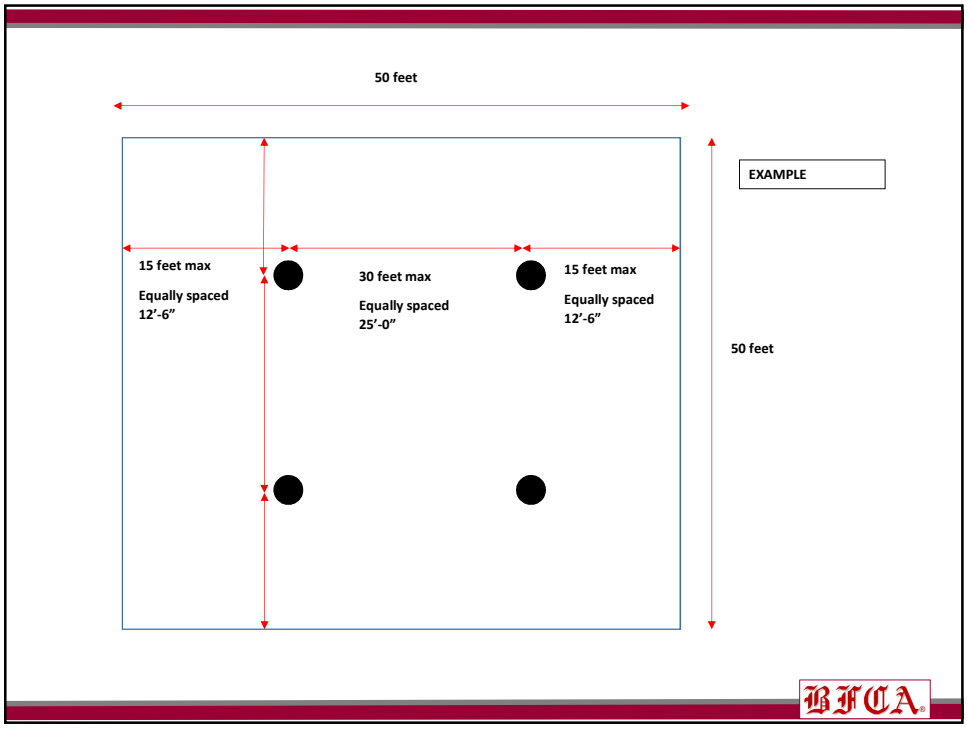


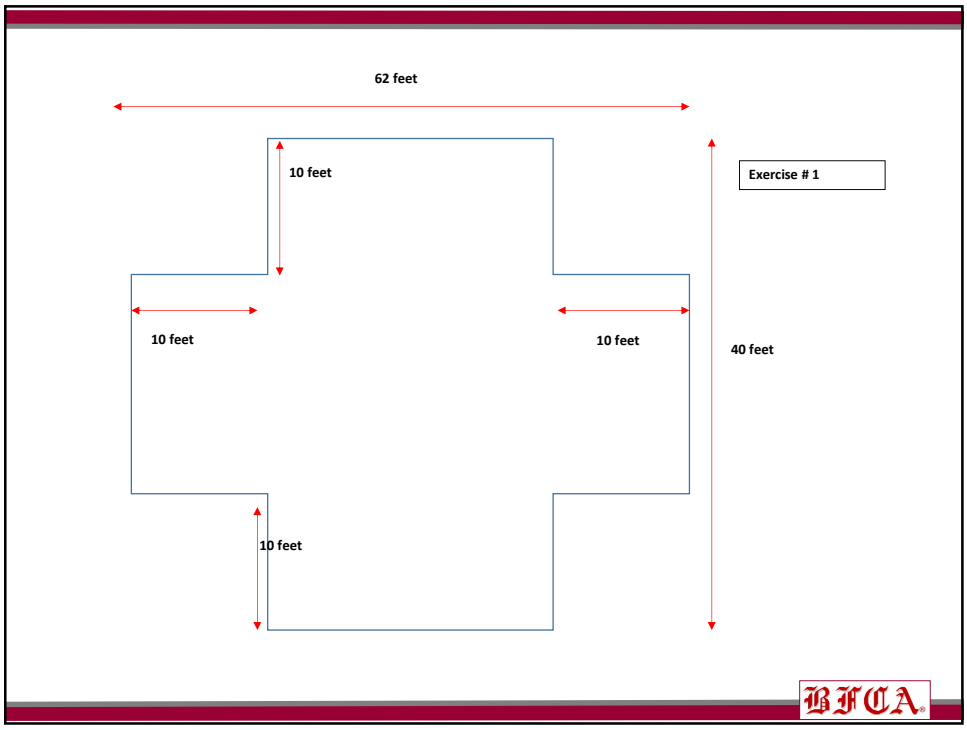
FIGURE A.17.6.3.1.1(h) Smoke or Heat Detector Spacing Layout in Irregular Areas.



- Question.
  - What is minimum number of smoke detectors to provide full detection for the room at standard spacing?

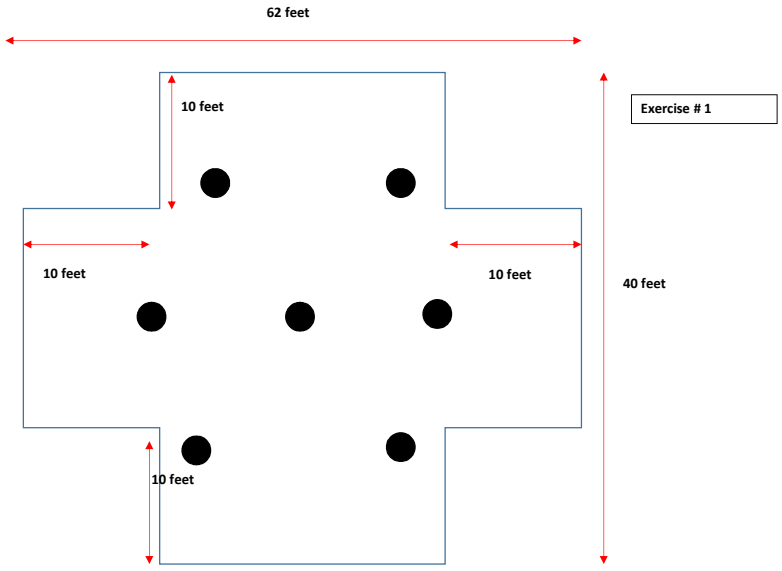
A 2	B 3
C 4	D 5

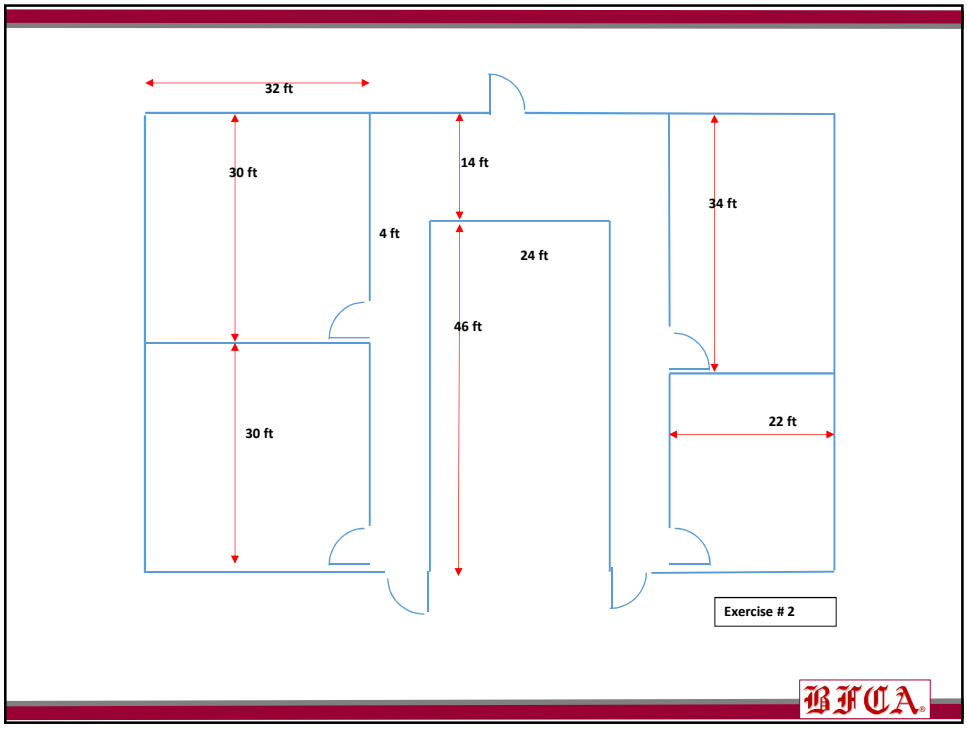

50 feet
EXAMPLE
15 feet max
Equally spaced
12’-6”
30 feet max
Equally spaced
25’-0”
15 feet max
Equally spaced
12’-6”
50 feet

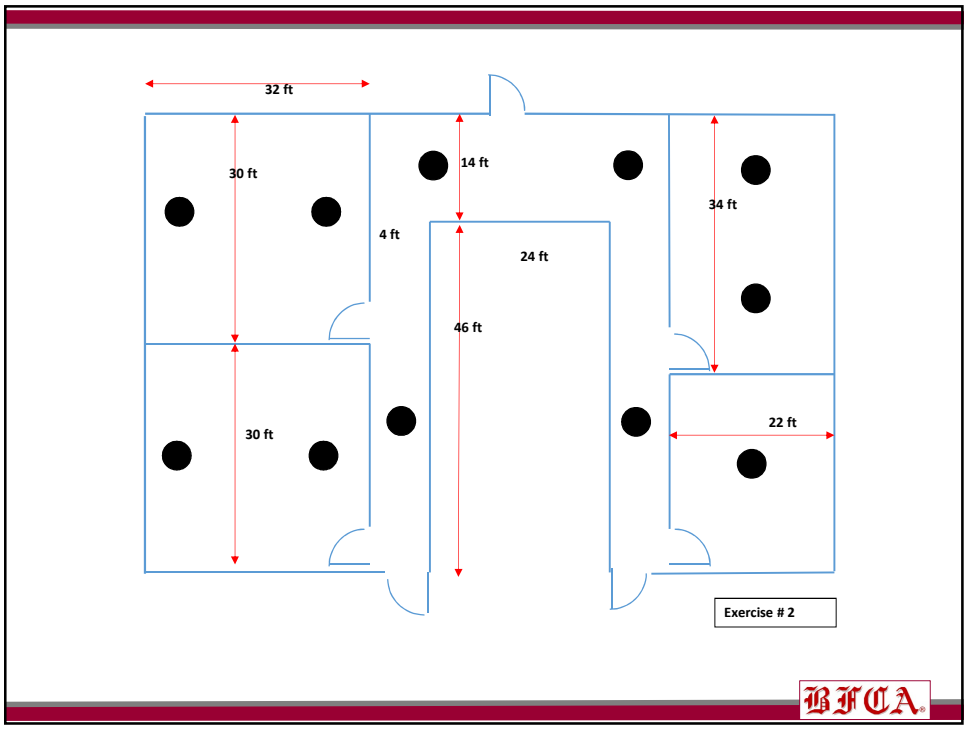

62 feet
Exercise # 1
10 feet
10 feet
10 feet
10 feet
40 feet

- Question.
  - What is minimum number of smoke detectors to provide full detection for the room at standard spacing?

A 6	B 7
C 8	D 9




32 ft
30 ft
14 ft
34 ft
4 ft
24 ft
46 ft
30 ft
22 ft
Exercise # 2


32 ft
30 ft
14 ft
34 ft
4 ft
24 ft
46 ft
30 ft
22 ft
Exercise # 2

- Other Types of Detectors
  - Air sampling / projected beam / raised floor or suspended ceiling
  - Each has specific spacing and installation requirements

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Notification Requirements

Building Better With Our Greatest Resource...Education®

BFCA

Audio Visual Notification Devices

- As required by Chapter 9 of the IBC and IFC
- As required by Chapter 11 of the IBC
- As required by ICC A117.1
- As required by accessibility code

BFCA

Alarm Notification and Notification Components

- Notification devices
  - Used to initiate evacuation or relocation of building occupants
  - Temporal Signal Required
  - Recommended signal type is Temporal 3 (ANSI S3.41)
  - Consists of ½ to 1 second on, ½ second off, ½ to 1 second on , ½ second off, ½ to 1 second on, and then 2 ½ seconds off before the process repeats
  - Generally run on separate circuits and referred to as notification circuits
  - Operation consumes majority of voltage capacity of fire alarm system

BFCA

Audible Devices

- Bells
  - Must have distinct sound from other bells or only be used for fire warning
  - Typically used as external notification devices for responding agencies
- Horns
  - Most popular
  - Low current demands and cost

BFCA

- Sirens
  - Generally used in outdoor or heavy industrial areas
- Speakers
  - Used in conjunction with voice evacuation messages
- Chimes
  - Generates soft pleasant tone similar to doorbell
  - Used where harsher tones may cause panic – Hospitals and Mental Health facilities
- Sounders
  - Mechanical or electrical devices
  - Capable of producing variety of tones

BFCA

Visual Devices

- Emit light flashes measured in Candela
- Output is field selectable
- Output determined by room size in design and approval phase of system review
- Outputs range – 15-30-60-75-110
- Various combinations available
  - Horn / Strobe
  - Speaker / Strobe
  - Chime / Strobe

Audible Devices

- Listed for the application / Suitable protected
- Characteristics
  - Maximum 110 decibels
  - Sound more than 60 seconds

* Public mode
  - 15 dB over normal average sound
  - 5 dB over maximum sound over 60 seconds
  - Measured 5’ above the floor
  - Inside elevator and restrooms – private mode
  - Can use lower number if sound reduction equipment is used

* Private mode
  - 10 dB over normal sound level
  - 5 dB over maximum sound over 60 seconds
  - Measured 5’ above the floor

* Sleeping mode
  - 15 dB over normal sound level
  - 5 dB over maximum sound over 60 seconds
  - 75 dB at the pillow

* Location
  - Top not less than 60” above floor
  - Not less than 6” below the ceiling
  - Speakers can be mounted in the ceiling

* Average ambient sound levels

Occupancy/Location	Avg Ambient Sound
Business	**55**
Educational	**45**
Industrial	**80**
Institutional	**50**
Mercantile	**40**
Mechanical Room	**85**
Assembly	**55**
Residential	**35**
Thoroughfares – Urban	**70**

BFCA

* Sound level calculations
  - Decibel rating is from 10’ from the device
  - Decibel rating is affected by construction materials and finishes
  - Decibel rating is affected by distance
    - Double the distance lose 6 decibels

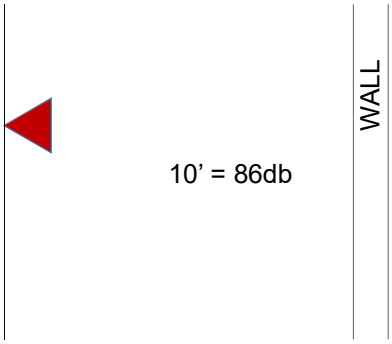
BFCA

* Decibel distance
  - Given a horn rated at 86 decibels at 10’

10’ = 86db 20’ = 80db 40’ = 74db

BFCA

- obstructions



10’ = 86db

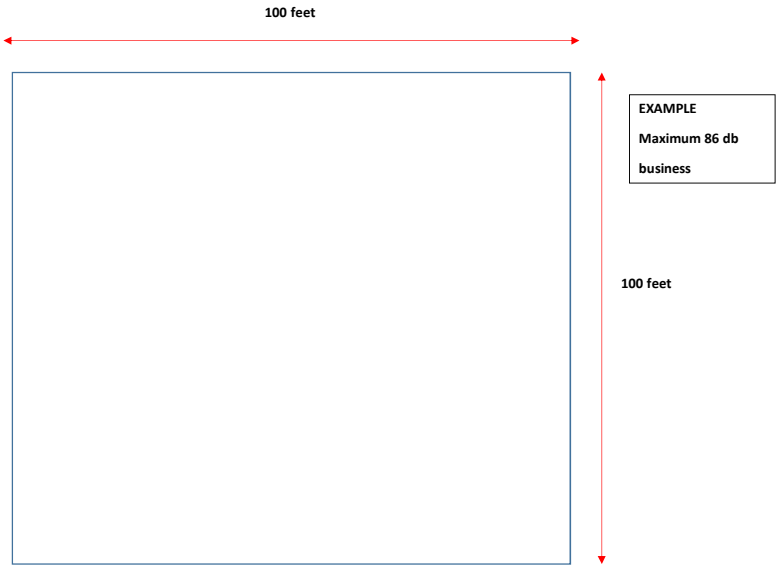
20’ = 80db

Including the wall 70 db

Rule of thumb 10 db loss

BFCA

* https://www.systemsensor.com/en-us/Pages/Sound-Pressure-Loss-Calculator.aspx



* Average ambient sound levels

Occupancy/Location	Avg Ambient Sound
Business	55
Educational	45
Industrial	80
Institutional	50
Mercantile	40
Mechanical Room	85
Assembly	55
Residential	35
Thoroughfares – Urban	70

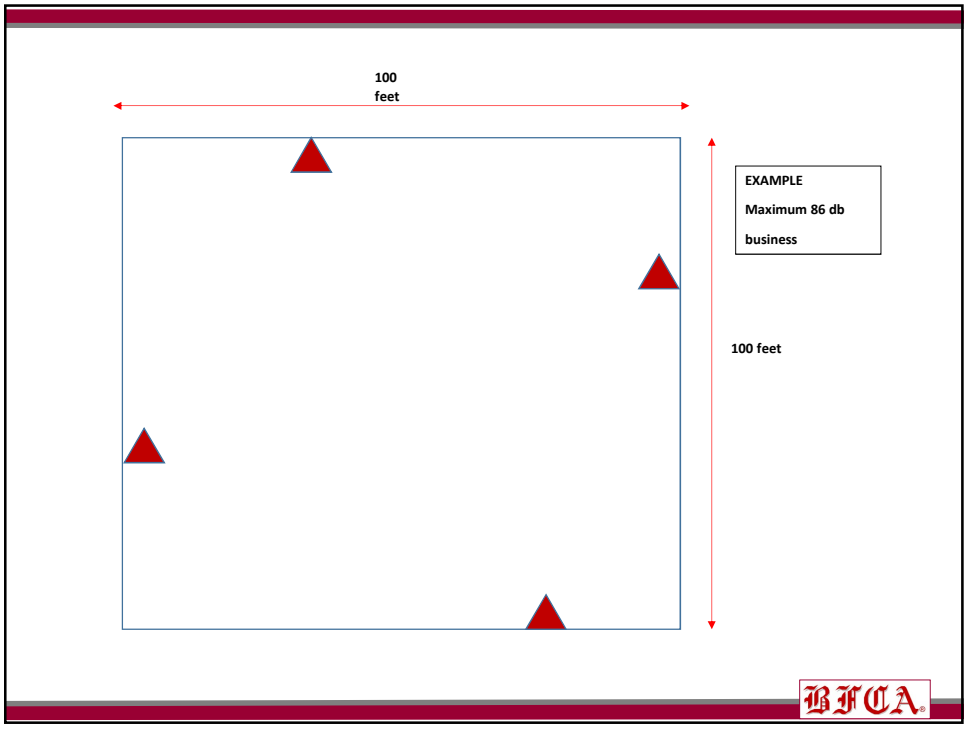
BFCA

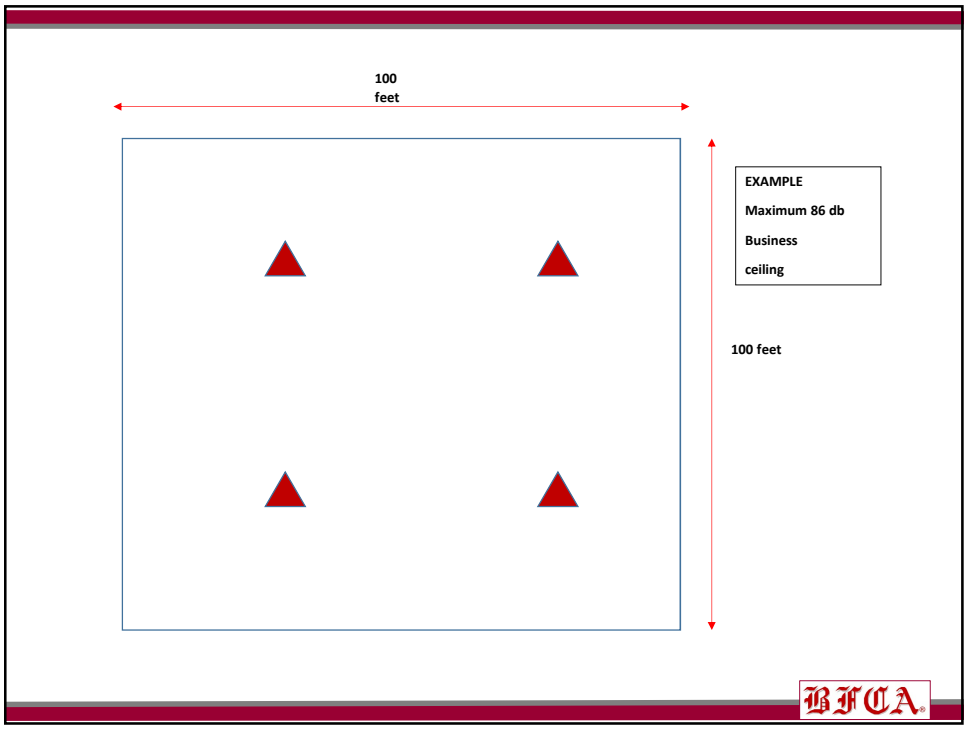
♦ Question.

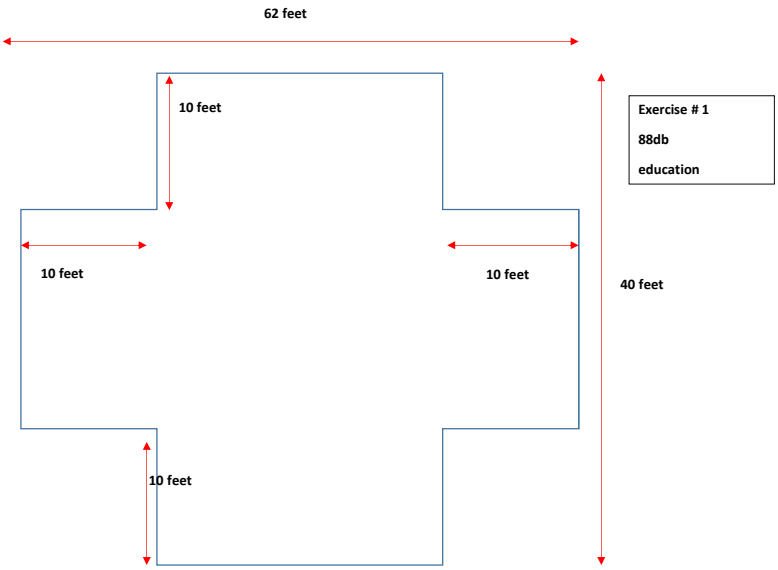
* What is minimum number of wall mounted horn notification devices?

A 1	B 2
C 3	D 4

BFCA

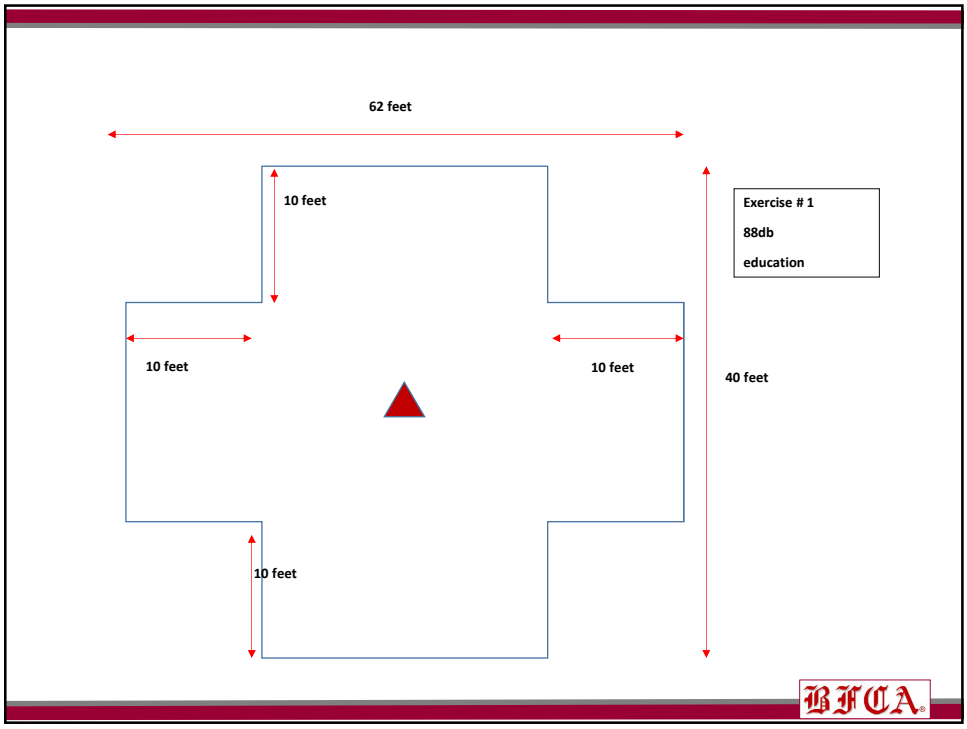

100
feet
EXAMPLE
Maximum 86 db
business
100 feet
BFCA

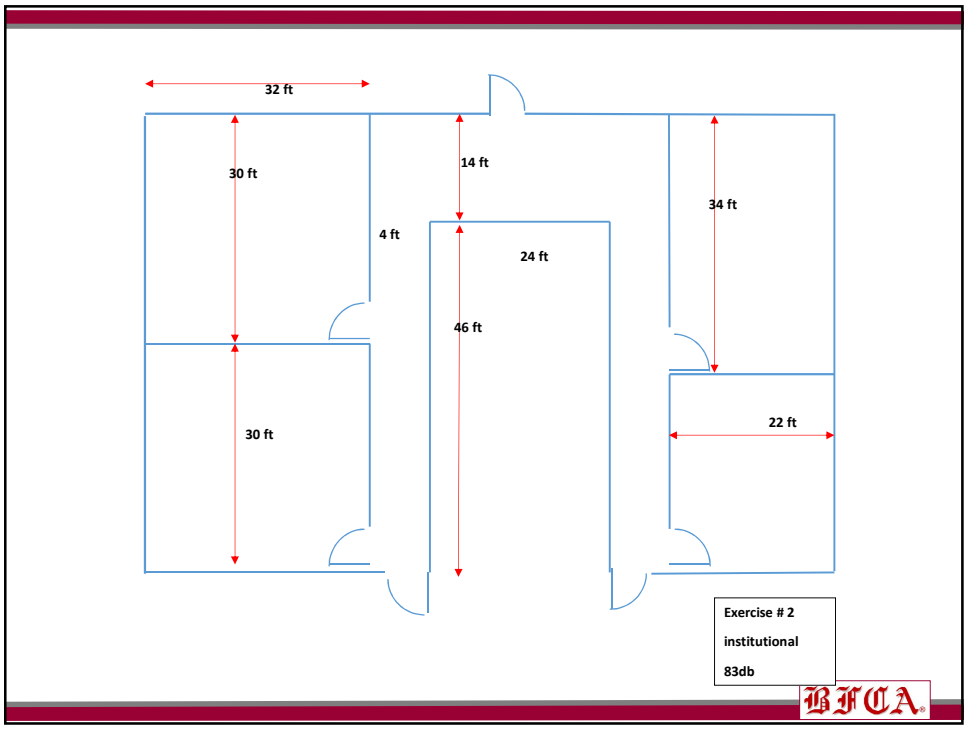

100
feet
EXAMPLE
Maximum 86 db
Business
ceiling
100 feet
BFCA

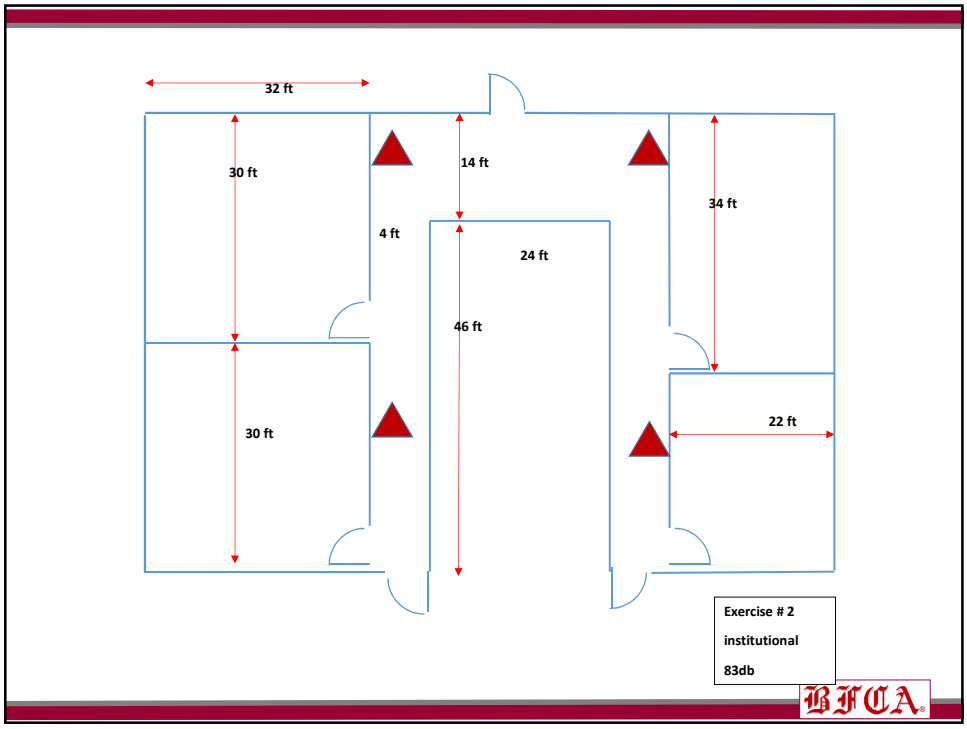


- Question.
  - What is minimum number of ceiling mounted horn notification devices?

A 1	B 2
C 3	D 4


62 feet
10 feet
10 feet
10 feet
10 feet
40 feet
Exercise # 1
88db
education


32 ft
30 ft
14 ft
4 ft
24 ft
34 ft
46 ft
30 ft
22 ft
Exercise # 2
institutional
83db



- Visual Devices
  - Location
  - Wall mounted
    - Entire lens not less than 80” above the floor
    - Not more than 96” above the floor
    - Ceiling height up to 30’
    - Inadequate height – within 6” of the ceiling
    - Measured 5’ above the floor
  - Spacing per
    - Table 18.5.5.5.1(a)
    - Figure 18.5.5.5.1
    - Table 18.5.5.5.1(b) Measured 5’ above the floor

* Intent
  - Minimum illumination level to all occupiable areas
    - 0.0375 lumens per square foot
  - Illuminate all areas with indirect viewing (reflected light)
    - Illuminate areas using single notification devices
  - Two devices on opposite ends
  - Synchronized when within view
  - More than two groups of devices

* Devices located more than 1/2 the distance off the wall
* Large areas are divided into areas consistent with the Tables
* Same rules apply to ceiling mounted devices

Table 18.5.5.5.1(a) Room Spacing for Wall-Mounted Visual Notification Appliances

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
ft	m	One Visual Notification Appliance per Room	Four Visual Notification Appliances per Room (One per Wall)
20 × 20	6.10 × 6.10	15	NA
28 × 28	8.53 × 8.53	30	NA
30 × 30	9.14 × 9.14	34	NA
40 × 40	12.2 × 12.2	60	15
45 × 45	13.7 × 13.7	75	19
50 × 50	15.2 × 15.2	94	30
54 × 54	16.5 × 16.5	110	30
55 × 55	16.8 × 16.8	115	30
60 × 60	18.3 × 18.3	135	30
63 × 63	19.2 × 19.2	150	37
68 × 68	20.7 × 20.7	177	43
70 × 70	21.3 × 21.3	184	60
80 × 80	24.4 × 24.4	240	60
90 × 90	27.4 × 27.4	304	95
100 × 100	30.5 × 30.5	375	95
110 × 110	33.5 × 33.5	455	135
120 × 120	36.6 × 36.6	540	135
130 × 130	39.6 × 39.6	635	185

NA: Not allowable.

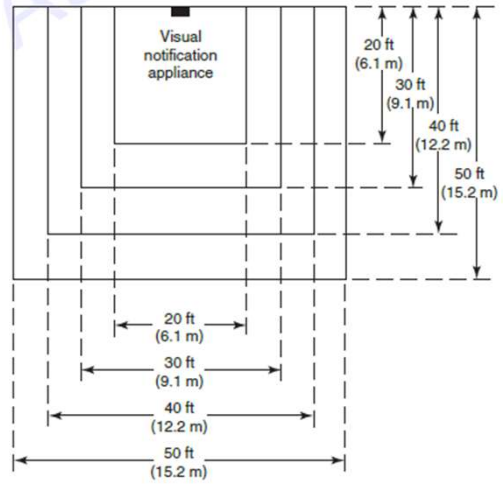


FIGURE 18.5.5.5.1 Room Spacing for Wall-Mounted Visual Notification Appliances.

Table 18.5.5.5.1(b) Room Spacing for Ceiling-Mounted Visual Notification Appliances

Maximum Room Size		Maximum Lens Height*		Minimum Required Light Output (Effective Intensity); One Visual Notification Appliance
ft	m	ft	m	(cd)
20 × 20	6.1 × 6.1	10	3.0	15
30 × 30	9.1 × 9.1	10	3.0	30
40 × 40	12.2 × 12.2	10	3.0	60
44 × 44	13.4 × 13.4	10	3.0	75
20 × 20	6.1 × 6.1	20	6.1	30
30 × 30	9.1 × 9.1	20	6.1	45
44 × 44	13.4 × 13.4	20	6.1	75
46 × 46	14.0 × 14.0	20	6.1	80
20 × 20	6.1 × 6.1	30	9.1	55
30 × 30	9.1 × 9.1	30	9.1	75
50 × 50	15.2 × 15.2	30	9.1	95
53 × 53	16.2 × 16.2	30	9.1	110
55 × 55	16.8 × 16.8	30	9.1	115
59 × 59	18.0 × 18.0	30	9.1	135
63 × 63	19.2 × 19.2	30	9.1	150
68 × 68	20.7 × 20.7	30	9.1	177
70 × 70	21.3 × 21.3	30	9.1	185

*This does not preclude mounting lens at lower heights.

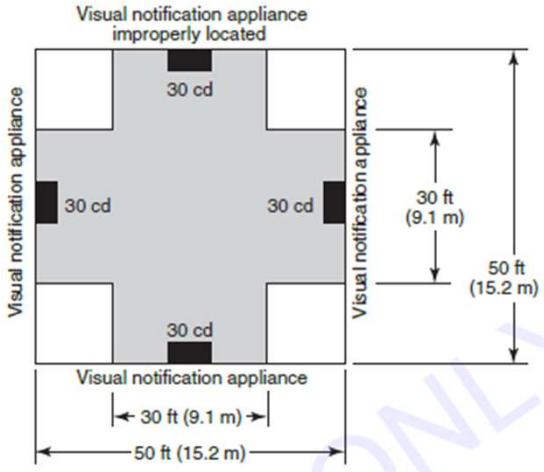


FIGURE A.18.5.5.5(d) Room Spacing Allocation — Incorrect.

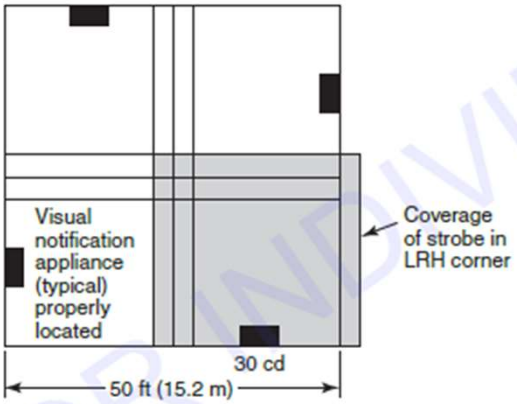
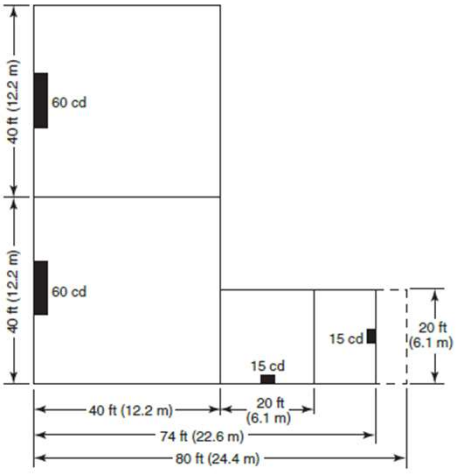
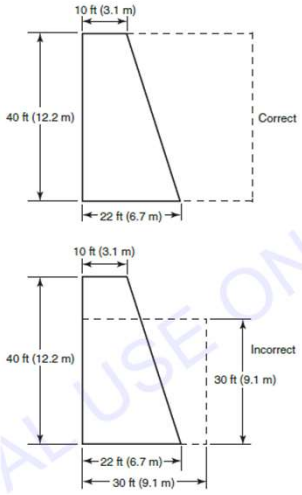


FIGURE A.18.5.5.5(c) Room Spacing Allocation — Correct.



Note: Broken lines represent imaginary walls.

FIGURE A.18.5.5.5(b) Spacing of Wall-Mounted Visual Notification Appliances in Rooms.



Note: Broken lines represent imaginary walls.

FIGURE A.18.5.5.5(a) Irregular Area Spacing.

BFCA

- Visual Devices
  - Corridors – 20’ or less
    - Comply with room spacing criteria
    - This section
      - Not less than 15 cd
      - Not more than 20’ from end of corridor
      - Maximum 100’ spacing
      - Physical or other separation – consider as new corridor
      - Synchronize

BFCA

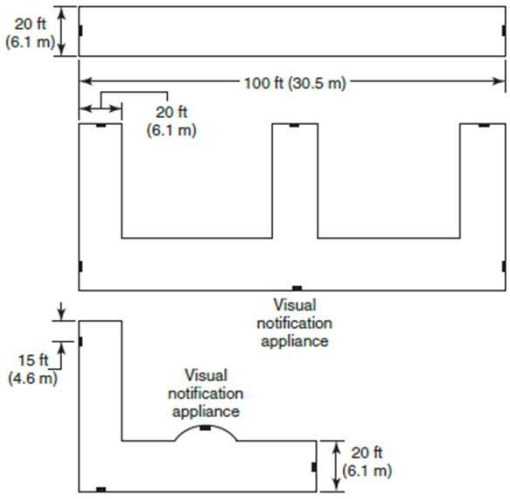
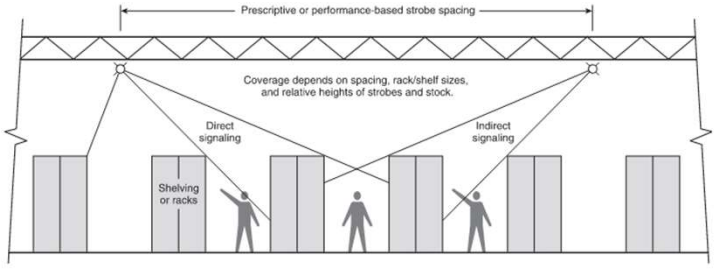
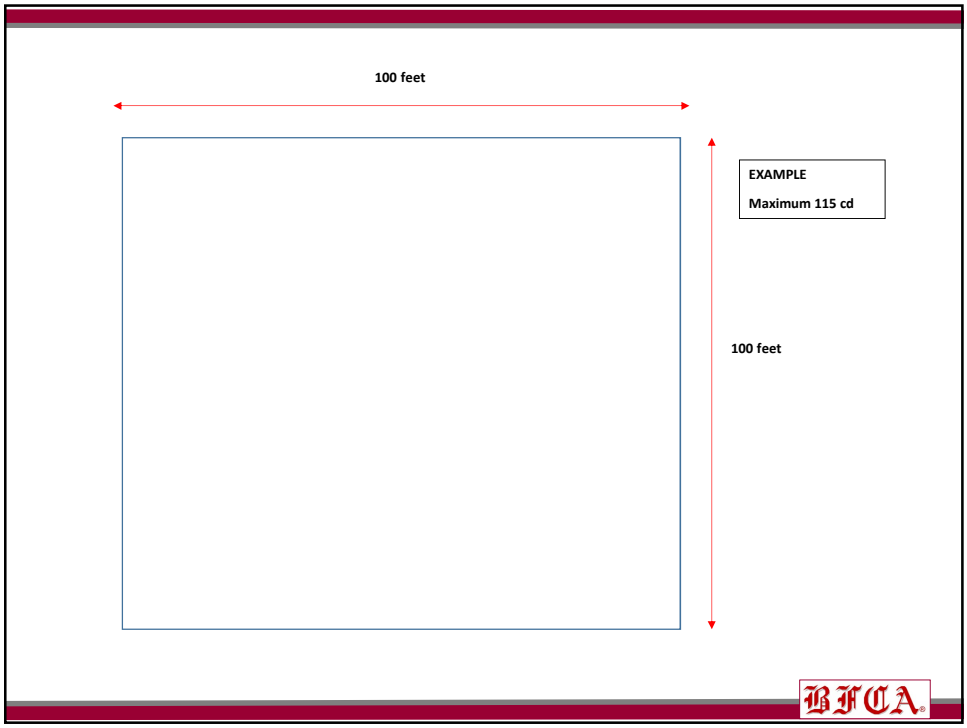


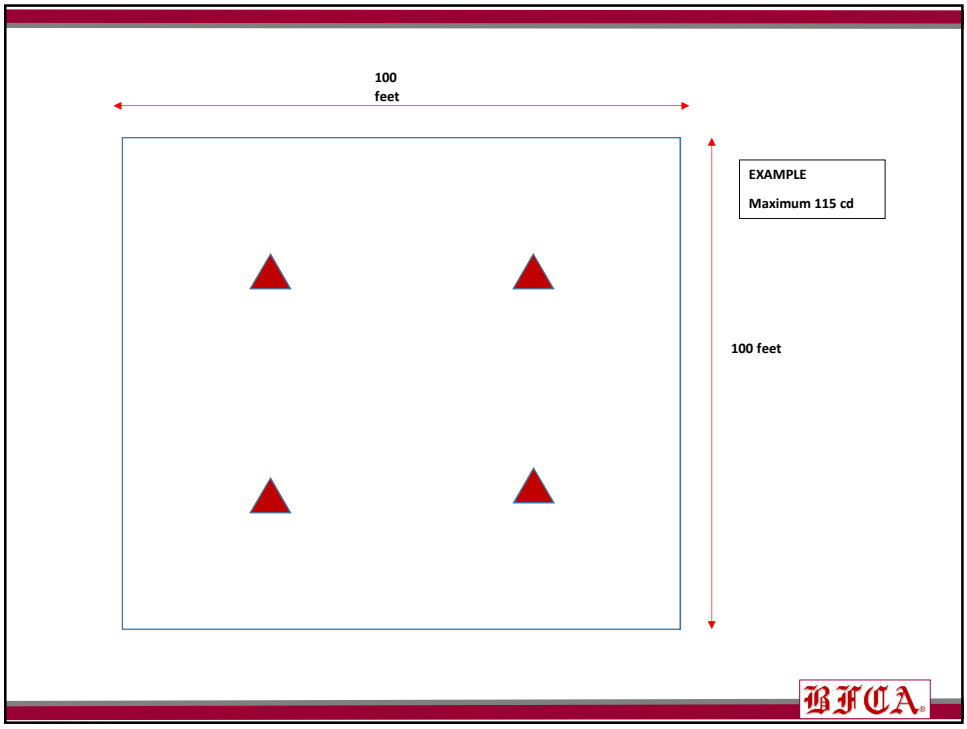
FIGURE A.18.5.5.6 Corridor Spacing for Visual Notification.





- Question.
  - What is minimum number of ceiling mounted visual notification devices?

A 1	B 2
C 3	D 4


100
feet
EXAMPLE
Maximum 115 cd
100 feet
BFCA

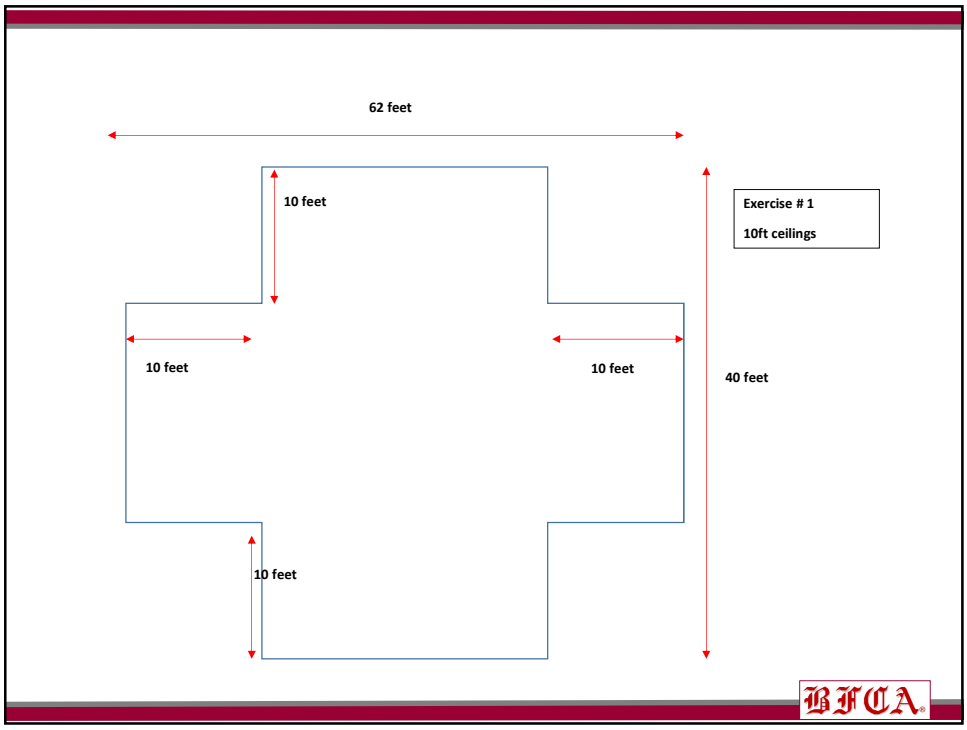

62 feet
10 feet
10 feet
10 feet
10 feet
Exercise # 1
10ft ceilings
40 feet
BFCA

Table 18.5.5.4.1(a) Room Spacing for Wall-Mounted Visible Appliances

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
ft	m	One Light per Room	Four Lights per Room (One Light per Wall)
20 × 20	6.10 × 6.10	15	NA
28 × 28	8.53 × 8.53	30	NA
30 × 30	9.14 × 9.14	34	NA
40 × 40	12.2 × 12.2	60	15
45 × 45	13.7 × 13.7	75	19
50 × 50	15.2 × 15.2	94	30
54 × 54	16.5 × 16.5	110	30
55 × 55	16.8 × 16.8	115	30
60 × 60	18.3 × 18.3	135	30
63 × 63	19.2 × 19.2	150	37
68 × 68	20.7 × 20.7	177	43
70 × 70	21.3 × 21.3	184	60
80 × 80	24.4 × 24.4	240	60
90 × 90	27.4 × 27.4	304	95
100 × 100	30.5 × 30.5	375	95
110 × 110	33.5 × 33.5	455	135
120 × 120	36.6 × 36.6	540	135
130 × 130	39.6 × 39.6	635	185

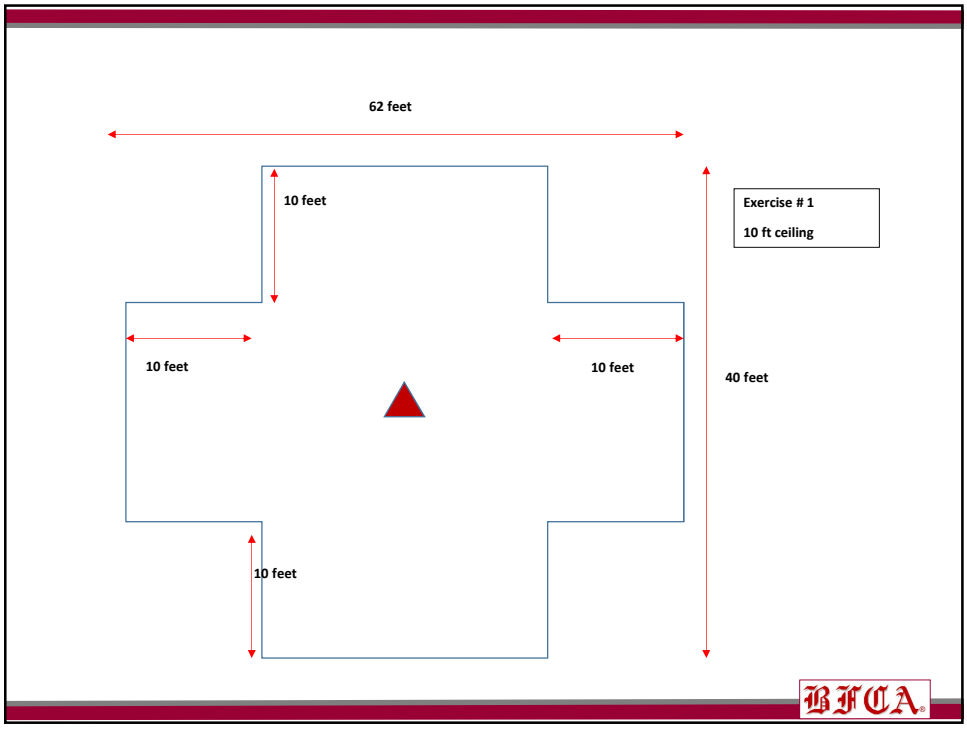
NA: Not allowable.

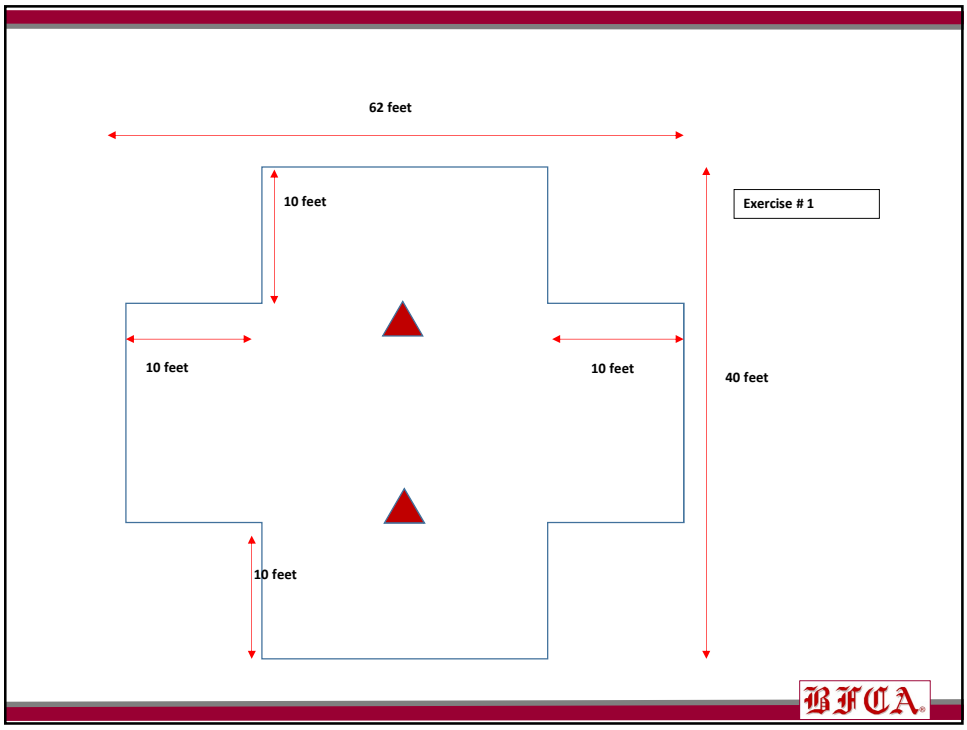
BFCA

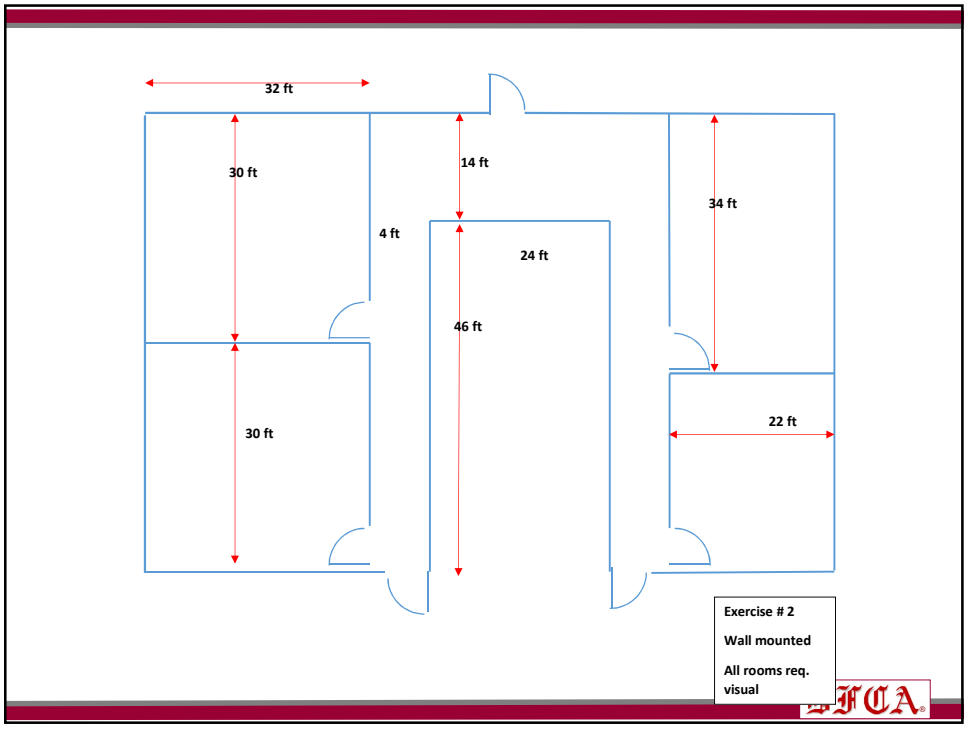
- Question.
  - What is minimum number of ceiling mounted visual notification devices?

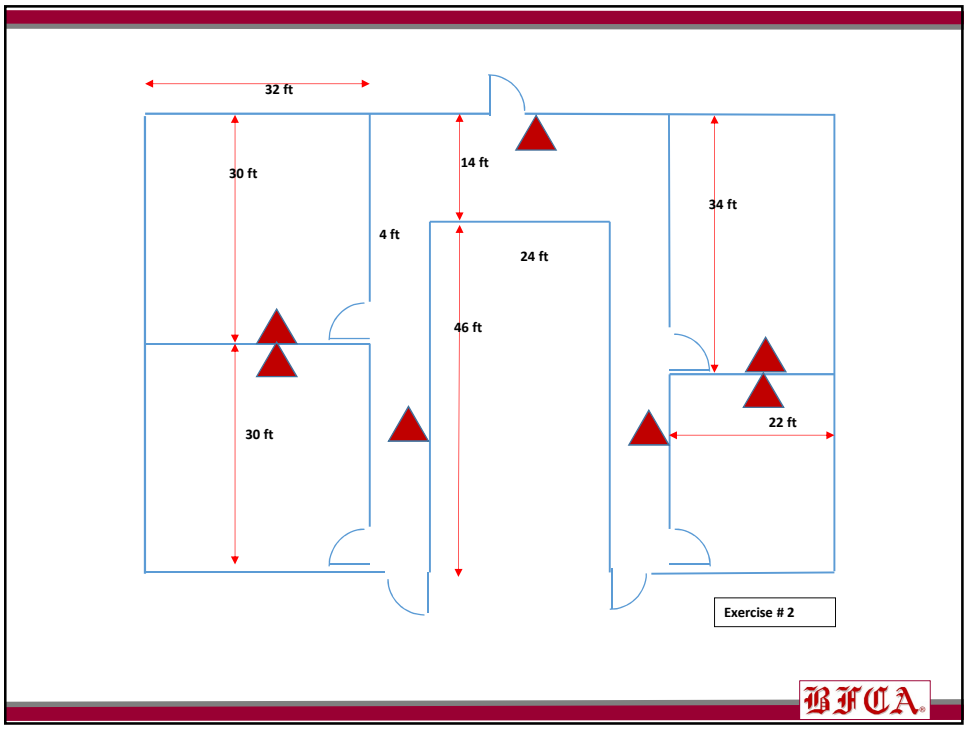
A 1	B 2
C 3	D 4

BFCA


62 feet
10 feet
Exercise # 1
10 ft ceiling
10 feet
10 feet
40 feet
10 feet
BFCA


62 feet
10 feet
Exercise # 1
10 feet
10 feet
40 feet
10 feet
BFCA


32 ft
30 ft
14 ft
4 ft
24 ft
34 ft
46 ft
30 ft
22 ft
Exercise # 2
Wall mounted
All rooms req. visual
BFCA


32 ft
30 ft
14 ft
4 ft
24 ft
34 ft
46 ft
30 ft
22 ft
Exercise # 2
BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Communication Methods

Building Better With Our Greatest Resource...Education®

BFCA

- Communication Methods
  - Active Multiplex
  - Digital Alarm Communication System (DACS)
  - McCulloh Systems
  - Two Way RF Multiplex Systems
  - Digital Alarm Radio Systems (DARS)
  - One-Way RF System
  - Direct Connect

BFCA

* Active Multiplex
  - Also known as derived channel
  - Became popular in 80's by telephone companies
  - Provided supervised communication method from FACP to monitoring station

BFCA

Communication Methods

* Digital Alarm Communication System (DACS)
  - Most popular in use today
  - DACT – Digital Alarm Communicator Transmitter (dialer)
  - DACR – Digital Alarm Communicator Receiver (receiver)
* McCulloh Systems
  - Not commonly used today
  - No longer approved
  - Used wind-up code wheels for unique transmission of address

BFCA

Communication Methods

- Two-Way RF (Radio Frequency) Multiplex Systems
  - Only capable of three signal options
  - Alarm
  - Supervisory
  - Trouble
  - No additional information provided to supervising station
  - Supervising station can send signals to radio transmitter

BFCA

Communication Methods

- Digital Alarm Radio Systems (DARS)
  - Can transmit exact information produced by the fire alarm control panel
- One-Way RF System
  - Can only transmit signal
  - Alarm, Supervisory and Trouble
  - No signals sent to transmitter

BFCA

- Communication Methods
  - Direct Connect System
    - Use reverse polarity
    - F/A directly wired to receiving equipment at supervising station
    - Reverse polarity module used to reverse polarity when alarm signal generated

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Construction Documents / Plans

Building Better With Our Greatest Resource...Education®

BFCA

- Symbols
  - All drawings use symbols
  - Must comply with NFPA 170 – Standard for Fire Safety and Emergency Symbols

  OR

  - Other symbols acceptable to AHJ
  - Shall be to scale – 7.4.2
    - On uniform size
    - Plan for each floor
    - Provide basic information
    - Provides basis for as-built drawings

BFCA

- Shall include – 7.5.2
  - Name of premises, owner and/or occupant
  - Name of installer or contractor
  - Location of protected premises
  - Device legend and symbols per
    - NFPA 170 (or other as accepted by AHJ)
  - Date of issue (and any revision dates)

BFCA

- Floor Drawings
  - To scale and include
    - Floor or level identification
    - Point of compass (N)
    - Graphic scale
    - All walls and doors
    - Partitions extending within 15% of ceiling height (when known)

BFCA

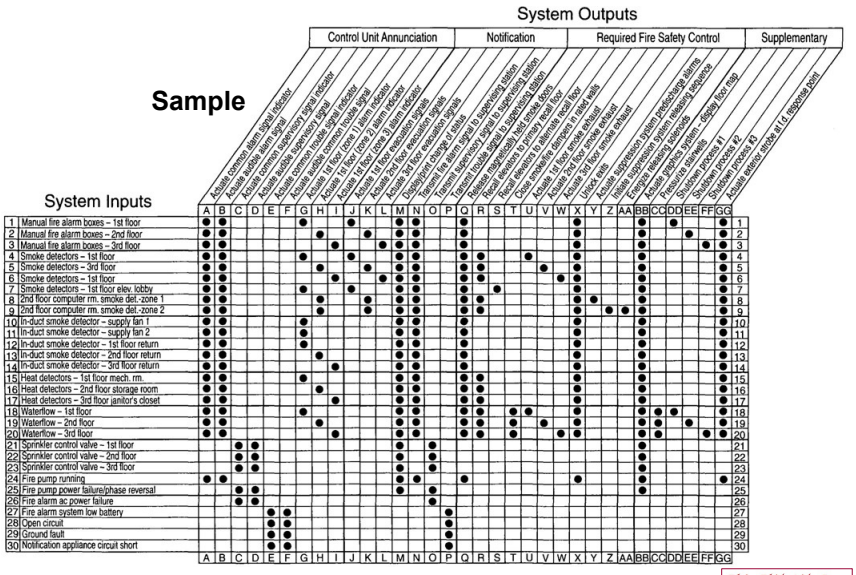
- Room and area descriptions
- System devices / Component location
- Location of primary power disconnecting means
- Location of monitor / Control interfaces to other systems
- System riser location
- Type and number of system components devices on each circuit, on each floor or level

BFCA

- Type and quantity of conductors and conduit (if used) for each circuit
- Identification of any ceiling over 10’ in height where automatic fire detection is being proposed
- Details of ceiling geometries, including beams and solid joists where automatic fire protection is proposed
- Acoustic properties of spaces, where known

BFCA

* Input / Output Matrix



BFCA

Plan Submittal Checklist

- Sufficient sets for review
- Equipment listed for intended use and compatible with system – cut sheets required
- Is a scale provided and plan information legible?
- Are all rooms labeled and room dimensions provided?
- Equipment symbol legend provided
- Type of fire alarm circuit (Class A or B) indicated

BFCA

- When detectors used
  - Location of devices
  - Mounting heights
  - Building cross sectional details shown
- Types of devices proposed indicated on plans
- Wiring used for alarm initiating alarms and signaling indicating devices detailed
- Location of FACU noted
  - Remote annunciator (if needed) provided

BFCA

* If more than one building served
  - Is each building identified separately on FACU or annunciator and noted on plans?
* Type and gauges of conductors indicated
* Section views
  - Structure
  - Roof
  - Ceiling
  - Rooms with beam or solid joists and drop ceilings

* Riser diagram shows
  - Number and type of devices installed on each circuit
  - Identification of fire alarm zones (if system not addressable)
  - Primary and secondary power supplies
    – Primary minimum 120 volts AC branch circuit labeled FIRE ALARM CIRCUIT
    – Access limited to authorized personnel

Point to Point System Wiring Diagram

- Interconnection and wire routing of identified devices and control for each circuit
- Indicate number of conductors and wire gauge for each circuit run
- Identify separate zones, circuits and end of line locations

Alarm Indication Circuit Voltage Drop Calculations

- Indicate
  - Number of signaling devices
  - Current consumption
  - End of line voltage for each circuit
  - Lowest nameplate operating voltage range for audible and visual notification devices
- Indicate the approximate length of each circuit and resistance of wire using the NEC conductor ampacity values or
- Provide manufacturer data sheet

* Provide calculations for acceptable circuit limits including
  - Standby power consumption of all current drawing devices times the hours required per NFPA 72 (24-hours) including power consumption of the control panel modules
  - Power consumption of all devices on standby power
  - The power consumption of all current consuming devices multiplied by the minutes required (5 minutes for fire alarms or 15 minutes for emergency voice/alarm communication service)

BFCA

Primary and Secondary Power

* Secondary power supply has minimum capacity of 24-hours and will alarm for 5 minutes (10.6.7.2.1)
* Secondary power supply for emergency / Voice alarm system has minimum ampacity of 24-hours and will alarm for 15 minutes (10.6.7.2.1.2)
* Batteries used for secondary power shall be sized to at least 100% of maximum normal load

BFCA

Initiating Devices

- Smoke and heat detection device coverage designed in accordance with:
  - Total coverage (17.5.3.1)
  - Partial coverage
  - Selective coverage
  - Non-required coverage

Detection Devices

- Wiring details for devices provided
- Type and location for the occupancy per IFC 907
- Duct detector locations in air / Heat ducts
  - Air flow rate per minute ratings are provided
  - Manufacturer data sheet and matrix or note detailing what size sampling tubes are to be used for each duct size 5.16.5

Detection Devices

- Location and spacing based on anticipated smoke flows due to plume and ceiling jet produced by an anticipated fire
  - Ceiling shape and surface
  - Ceiling height
  - Configuration of contents
  - Combustion characteristics of fuel load
  - Compartment ventilation
  - Ambient pressure, pressure, altitude and humidity
  - Provide document confirming variables were considered
  - Fire code official may require supporting documentation

BFCA

Listed

- Equipment – Material – Service
- Acceptable to AHJ
- Concerned with evaluation of products or services
- States equipment or material or service meets standards
- Has been tested and found suitable for specific purpose

BFCA

- Addressable Device
  - Component of fire alarm system
  - Discreet identification
  - Can have status identified
  - May be used to control other functions

BFCA

BFCA®
Building & Fire Code Academy

Understanding Fire Alarm Basics

Inspection, Testing, and Maintenance

Building Better With Our Greatest Resource...Education®

BFCA

- Inspection, Testing, and Maintenance
  - Applies to new and existing systems
  - Maintenance program required
    - Comply with code
    - Conform to manufacturer's requirements
    - Correct operation of all maintenance
    - Repair all deficiencies

BFCA

  - Responsibility
    - Property or business owner
    - Performed by outside agency under contract
  - Qualified
    - Factory trained or certified
    - Certified
    - Registered, licensed by local or state authority

BFCA

* Notify occupants
  - Before and after test
* Visual inspection per Table 14.3.1
* All systems and equipment tested
  - Notify local official
  - All equipment
  - New equipment added or equipment deleted
  - Modifications to control equipment
  - Changes made to software

* Smoke detector sensitivity after one year
  - Every alternate year
  - All tested within 5 years
* Testing frequency per Table 14.4.3.2
  - Comply with code
  - Conform to manufacturer requirements

* Maintenance
  - Per manufacturer
  - Base on equipment and conditions
    - Comply with the code
    - Conform to the manufacturer requirement
* Records
  - Acceptance test results in writing
  - Reproducible as built drawings
    - Operations and maintenance manuals
    - Sequence of operations
    - List of all information 14.6.2.4

BFCA

Fire Alarm Reliability

* All fire alarm devices and components will eventually fail
  - Proper system design, maintenance and testing extends life of system and reliability
* Top reasons for malfunctions
  - Faulty water flow switch
  - Poor maintenance
  - Water in conduit
  - Battery failure
  - Smoke detectors too sensitive
  - Poor or improper installation

BFCA

* Top reasons for malfunctions
  - Telephone line failure
  - Power failure
  - Detector failure
  - Damage to device
* Proper design is vital
  - Using smoke detectors instead of heat detectors in elevator hoistways, kitchens, and laundry rooms will generate false alarms

BFCA

Fire Alarm System Service and Maintenance

* NFPA 72 requires building owner take responsibility for having alarm system tested and inspected
* Acceptance test required on all new systems
* Smoke detector sensitivity required to be checked within the first year of installation
  - After first year testing required every alternate year
  - If sensitivity remains within the listed range can be extended to five years

BFCA

- Overview
  - FACP
  - Initiating
  - Notification
  - Power
  - Wiring

BFCA

BFCA®
Building & Fire Code Academy

Questions?

Building Better With Our Greatest Resource…Education®

BFCA

BFCA®
Building & Fire Code Academy

Thank You!

Building Better With Our Greatest Resource…Education®

BFCA®
Building & Fire Code Academy

Website	**bfcacademy.com**
Email	**info@bfcacademy.com**
Voice	**(800) 488-7057 (847) 428-2951**
Fax	**(847) 428-2911**

Building Better With Our Greatest Resource…Education®

File Attachments for Item:

OB-1 Changes to BBS Education Classification system

At the May meeting BBS staff briefly introduced an updated education approval application which changes the way courses are approved for certifications. Staff email and proposed new application, existing application are attached. Item was tabled in June, bringing back for discussion and adoption.

Committee Recommendation:

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format.

Certificate of Completion: Course providers shall provide participants a certificate of completion containing the following information:

- name of participant
- title of approved courses
- BBS approval #
- BBS approved certifications
- date of the continuing education program
- number of approved credit hours awarded, and
- signature of authorized sponsor or instructor.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the ceus, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
Sufficient seating capacity
ADA accessible facilities
Appropriate Audio/Visual devices for delivery
Writing surfaces for participants

Online Classes:
Web-accessible
ADA accessible delivery
Tech support available
Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Application for Continuing Education Course Approval

Provider Information:

Name:_____
Organization:_____
Address:_____
E-mail: _____ Telephone:_____
Website:_____
Conference Sponsor (if applicable)_____Conference Email:_____

Check here if Course Renewal:_____Prior course number _____ (*i.e. BBS2018-429*)
Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title:_____
Course instructor:_____
Course description:_____
_____
_____
_____
Instructional hours per session:_____ Number of Sessions:_____
Course Date and Location:_____

Special Content:

Code Administration:_____ Conference Course: _____
Existing Buildings: _____ Conference Name: _____
Electrical Instruction: _____ Conference location:_____
Plumbing Instruction:_____

Course to be offered online?_____ **On Demand_____** **Webinar_____**
Course Website: _____
Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation*):
_____

Course applicable for the following certifications

Residential Certifications Only: _____ Commercial and Residential Certifications: _____
Administrative Course, all Certifications: _____

Application materials included:

_____ Course Outline or Course Learning Objectives
_____ Presentation Materials/Slides (not required for roundtable courses)
_____ Assessment Materials (for online courses)
_____ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov

The board does not provide retroactive approval for continuing education courses.

CRITERIA FOR SUBMITTING CONTINUING EDUCATION COURSES FOR BOARD OF BUILDING STANDARDS CERTIFICATIONS

The Ohio Board of Building Standards approves Continuing Education Courses for building department personnel. The courses may be used for the attainment of goals that are connected with technical and professional development as they relate to enforcing and interpreting the Ohio State Building Codes. Board approval is granted only on course instruction pertaining to OBC, OMC, OPC, and RCO requirements and such other content areas directly related to the responsibilities of the certification for which credit is being requested.

Instructors: Anyone or any organization promoting an approved course, is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, certifications for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising shall not disclose improper approval information to the public.

Course sponsors/co-sponsors: provide participants a certificate of completion containing the following information: name of participant, title of approved courses, BBS approval #, BBS approved certifications, date of the continuing education program, number of approved credit hours awarded and signature of authorized sponsor or instructor.

Anyone or any organization administering an approved course shall provide the Board with advanced written information on scheduling of the course(s) (date and place) and provide to the Board a legible list of participants who completed the course with the name of course, date, and location.

Participants: Must attend the complete course as presented by the instructor to receive credit hours approved by the Board. No partial credit shall be given to any participant who failed to complete the entire course as approved. The sponsor/co-sponsor or instructor shall formulate a method to verify the individual's attendance and completion of the course.

Board approval: Remains in effect through the calendar year of approval. The course may be renewed administratively by sponsor application in subsequent years so long as it references current codes and standards Upon the Board's adoption of a new edition of the codes, course sponsors must update their course and submit to the Board for approval. The Board does not grant retroactive approval for courses presented prior to approval date.

Facility/training area: Shall be capable of comfortably and safely seating at least the number of attendees with writing surfaces for each attendee; accessible to/and usable for people with disabilities; sized and provided with audio/visual equipment adequate so that each attendee can see the instructor(s) and overhead screen and hear the content of the training programs; illuminated for writing and that the content on an overhead screen can be seen easily by all attendees; non-smoking in the training room; sound controlled so that outside noise will not interfere with the training.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: _____
(Contact Name)

Organization: _____
(Organization/Company)

Address: _____
(Include Room Number, Suite, etc.)

City: _____ State: _____ Zip: _____

E-Mail: _____

Telephone: _____ Fax: _____

Course Sponsor: _____

COURSE INFORMATION:

Course Title: _____

New Course Submittal: ☐ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: _____

Number of Instructional Contact Hours that can be obtained upon completion: _____

If Multi-Session, Number of Instructional Contact Hours Per Session: _____

Program Applicable for the Following Participants:

Building Official ☐ Master Plans Examiner ☐
Building Plans Exam. ☐
Plumbing Plans Exam. ☐
Electrical Plans Exam. ☐
Mechanical Plans Exam. ☐
Fire Protect. Plans Exam. ☐

Building Inspector ☐ Fire Protection Inspector ☐ Mechanical Inspector ☐
Plumbing Inspector ☐
Non-Res IU Inspector ☐

Res Building Official ☐ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☐
Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:		
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

From:	Foley, Megan
To:	terrymccafferty; abstanbery@abstanberyinc.com; julie.cromwell@juliecromwell.com; Jeffrey Tyler; Jeff Samuelson; Greg Warner
Cc:	Hanshaw, Regina; Lane, Michael; Timothy Galvin
Subject:	Proposed new education form
Date:	Friday, May 20, 2022 3:32:00 PM
Attachments:	image001.png Updated Education Form 2022.pdf 216 - CRITERIA APP FOR SUBMITTING COURSES 2018.pdf

---

Education Committee members:

As I reported briefly at the May 12 meeting, Regina and I have been discussing how to simplify our continuing educational requirements , especially in light of both our rules revision and planned new online personnel application and renewal portal/program.
The attached form is a proposed starting place for this change. I have included the current form (216) for comparison.

The main changes implemented on the proposed form:

1. Consolidation. Instead of listing each commercial and residential certification for inclusion in the CE credit, the form has three categories, Residential, Commercial, and All Certifications. The committee has expressed an interest in promoting cross-training, and this consolidation is a step towards that goal.
   Other categories for this could be 'Residential Only', 'Commercial and Residential', and 'Administrative'.

2. Simplified Reporting: Certified personnel will no longer have to worry if the courses they take qualify as education for the certifications they hold, beyond the broad classification of commercial and residential. This will also simplify staff review of renewals, and will simplify online reporting for course sponsors once the new program is adopted.

3. Tracking additional information: The new form provides course sponsors an opportunity to indicate if a course is an administrative course, if the course is being offered online, if the course is part of a conference, etc.

I welcome any changes and suggestions for improvement.

Ohio Department of Commerce
Ohio Board of Building Standards

Meg Foley
Professional Development Coordinator
Board of Building Standards
Department of Commerce
614.644.3779
mfoley@com.state.oh.us
Board of Building Standards

-

This message and any response to it may constitute a public record and thus may be publicly available to anyone who requests it.

File Attachments for Item:

OB-2 Education credit for recruitment/outreach activities

Chris Parmelee, BO for Lakewood Ohio, attending to discuss outreach activities he has performed.

Sample reporting form for discussion.

Building Department Personnel
Community Outreach Record

Name:_____ BBS ID:_____

Date	Organization	Activity	Hours

I certify that this is a true and correct statement of outreach activities I have personally completed during the last renewal period, _____ (dates)

_____
Signature

Certified Personnel may receive up to 15 hours credit each renewal period for performing community outreach activities which increase the visibility of the OBC and RCO, their building departments, and the code administration profession.

Qualifying outreach activities include:

Career Fairs
School and Career Center appearances
Apprenticeship Program talks
Construction Industry Groups
Community Fair/Festival Booth
Department Open House

Other activities not listed here may qualify: contact BBS at 614-644-2613 BBS@com.ohio.gov

File Attachments for Item:

EC-1 Overview of Chapter 1 of the RCO (Kurtz, Robert)

All Certifications (1.5 hours)

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER: Robert Kurtz, Cert. #812

Course Submitter: Robert Kurtz
(Contact Name)

Organization: _____
(Organization/Company)

Address: 12010 W. Lake Rd.
(Include Room Number, Suite, etc.)

City: Vermilion State: OH Zip: 44089

E-Mail: inspectorkurtz@gmail.com

Telephone: 440-320-6801 Fax: _____

Course Sponsor: _____

COURSE INFORMATION:

Course Title: Overview of Chapter 1 of the Residential Code of Ohio

New Course Submittal: ■ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: To present an overview and provide a general understanding of Chapter 1, Administration, of the Residential Code of Ohio with easy to understand descriptions.

The course is designed as an educational opportunity for individuals new to building code enforcement as well as a refresher for all individuals that are already involved in code enforcement.

Number of Instructional Contact Hours that can be obtained upon completion: 1.5

If Multi-Session, Number of Instructional Contact Hours Per Session: _____

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ☐ Building Inspector ■ Fire Protection Inspector ☐ Mechanical Inspector ☐
Plumbing Plans Exam. ☐ Plumbing Inspector ☐
Electrical Plans Exam. ☐ Non-Res IU Inspector ☐
Mechanical Plans Exam. ☐

Res Building Official ■ Res Plans Examiner ■ Res Building Inspector ■ Res Mechanical Inspector ■ Res IU Inspector ■

Electrical Safety Inspectors ☐
Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	X
Course Sponsor:	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	X
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	X
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	X
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	X
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	X
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	X
Test Materials:	Copy of quizzes or tests to be given	
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Residential Code

Overview of Chapter 1 of the Residential Code of Ohio

Robert Kurtz

- Certified Building Official
- Certified Building Inspector
- Certified Residential Building Official
- Certified Residential Plans Examiner
- Certified Residential Building Inspector
- Certified Fire Safety Inspector
- Building Code Enforcement for 22 years.
- OBOA Board of Directors
- Asst. Fire Chief

Chapter 1
Administration

Section 101.2 Scope

- Applies to-

  - One-, Two-, and Three-Family Dwellings
  - Any appurtenances connected or attached to such buildings.
  - Any accessory structure incidental to the dwelling.

What's the difference?

Appurtenance-

- Not defined in the RCO
- Accessory object
- Something subordinate to a more important thing

Accessory Structure is "a building, the use of which is incidental to that of the dwelling(s) and that is located on the same lot"

- Defined in Chapter 2 of the RCO
- Building defined by Merriam-Webster as a *"usually roofed and walled structure built for permanent use*"

EXCEPTIONS

- Manufactured Homes
- Dwellings greater than 3 stories
- Dwellings attached to commercial occupancies
- Buildings & structures containing two/three dwelling units with shared exit
- Buildings/Structures incidental to agricultural use
- Agricultural labor camps
- Type A or Type B family day care homes
- Federal & State military buildings
- Sewage treatment buildings
- Building sewer piping
- Private water systems
- Wind turbines, pumps, site lighting & flagpoles NOT connected to building service equipment
- Fixed or floating docks, including electric if NOT connected to building service equipment
- Retaining walls, bridges, walkways, or site stairs unless associated with or necessary for the building or building egress
- Components, equipment, and systems for which there are no provisions in this code the provisions of the OBC apply
- Buildings regulated by the OBC but are permitted to use construction requirements of this code remain within the scope of the OBC

Section 101.3 Intent

"The purpose of this code is to establish uniform minimum requirements for the erection, construction, repair, alteration, and maintenance of residential buildings, including construction of industrialized units."

Section 101.4
Reasonable Application

Alexander Hamilton

The powers contained in a constitution…ought to be construed liberally in advancement of the public good.

- "The rules of the Board and proceedings shall be liberally construed in order to promote its purpose. When the residential building official finds that the proposed design is a reasonable interpretation of the provisions of this code, it shall be approved."

SHALL

RCO Section 202

"The term, where used in this code, is construed as mandatory."

LIBERALLY CONSTRUED

"The interpretation of a document shall not only be based on the actual words and phrases used in it, but also by taking its deemed or stated purpose into account".

(www.lawinsider.com)

Does it meet the intent of the code?

Section 102.3 Rules of the Board

Rules of the Board of Building Standards shall supersede and govern any order, standard, or rule of:

- State Fire Marshal
- Division of Industrial Compliance
- Health Departments

One exception!

- Orders issued by the fire marshal pursuant to Chapter 3743 of the Revised Code shall prevail in the event of a conflict.

Section 102.8 Non-Required Work

Any component, building element, equipment, system, or portion thereof NOT REQUIRED by this code shall be permitted to be installed provided it is constructed or installed in accordance with this code to the extent of installation.

Examples-

- Fire protection systems
- Elevators

Section 102.9 Temporary Structures

- RBO is authorized to issue approvals for temporary structures.
- Approval shall be in the form of a “Certificate of Occupancy for a Temporary Structure”.
- Temporary structures shall conform to the requirements for-
  - Structural strength
  - Fire safety
  - Means of egress
  - Accessibility
  - Light
  - Ventilation
  - Sanitary
- RBO is authorized to terminate the approval & order use discontinued if conditions of approval are violated or the structures poses an immediate hazard.

Section 102.10
Work Exempt from Approval
BUILDING

- One-story detached structures used as tool & storage sheds, playhouses and similar uses, provided the floor area does not exceed 200 sq. ft. and playground structures.
- Fences not over 6’ high.
- Retaining walls not over 4’ in height, measured from bottom of footer to top of wall, unless supporting a surcharge.
- Water tanks supported directly on grade with capacity not exceeding 5000 gallons & the ratio of height to diameter or width does not exceed 2:1.
- Sidewalks & driveways not more than 30” above grade and not over a basement or story below and which are not part of the accessible route.
- Painting, papering, tiling, carpeting, cabinets, counter tops, similar finish work.
- Swings and other playground equipment accessory to a one, two, or three family dwelling.
- Window awnings supported by an exterior wall which do not project more than 54” and don’t need additional support.
- Decks not exceeding 200 sq. ft., not more than 30” above grade at any point, are not attached to the dwelling, and do not serve an exit door required by Section 311.2.
- Above-ground storage tanks as defined in Rule 4101:8-2-01 of the OAC & the associated tank foundations.
- Battery operated smoke & carbon monoxide alarms installed in existing buildings where no construction is taking place.

Section 102.10 Work Exempt from Approval Electrical

- Listed cord-and-plug connected temporary decorative lighting.
- Reinstallation of attachment plug receptacles but not the outlets thereof.
- Replacement of branch circuit overcurrent devices of the required capacity and type in the same location.
- Electrical wiring, devices, appliances, apparatus, or equipment operating at less than 25 volts and not capable of supplying more than 50 watts of energy.
- Repairs and Maintenance: Approval shall not be required for minor repair work, including the replacement of lamps or the connection of approved portable electrical equipment to approved permanently installed receptacles.
- Process equipment and the associated wiring on the load side of the power disconnect to the equipment.
- Electrical wiring equipment not connected to building services equipment in and adjacent to natural or artificially made bodies of water as defined in Article 682 of NFPA 70.

Section 102.10 Work Exempt from Approval Gas

- Portable heating, cooking, or clothes drying appliances.
- Replacement of any minor part that does not alter approval of equipment or make such equipment unsafe.
- Portable fuel cell appliances that are not connected to a fixed piping system and are not interconnected to a power grid
- Gas distribution piping owned and maintained by public or municipal utilities and located upstream of the point of delivery.
- Process equipment, including associated tanks, foundations, and process piping. For combination building services/process or power piping systems, the power or process piping located downstream of the control valve which separates the process from the building services piping is exempt from approval.

Section 102.10
Work Exempt from Approval
Mechanical

- Portable heating appliances.
- Portable ventilation equipment.
- Portable cooling units.
- Steam, hot or chilled water piping within any heating or cooling equipment regulated by this code.
- Replacement of any part that does not alter approval or equipment or make such equipment unsafe.
- Portable evaporative cooler.
- Self-contained refrigeration systems containing 10 lbs. or less of refrigerant or that are actuated by motors of one horsepower or less.
- Portable fuel cell appliances that are not connected to a fixed piping system and are not connected to a power grid.
- Heating and cooling distribution piping owned and maintained by public or municipal utilities.
- Process equipment including the associated tanks, foundations, and process piping. For combination building services/process or power piping systems the power or process piping located downstream of the control valve which separates the process from the building services piping is exempt from approval.

Section 102.10 Work Exempt from Approval Plumbing

- The repair of leaks in drains, water, soil, waste or vent pipe; provided, however, that if any concealed trap, drain-pipe, water, soil, waste or vent pipe becomes defective and it becomes necessary to remove and replace the same with new material, such work shall be considered as new work and an approval shall be obtained and inspection made as provided in this code.
- The clearance of stoppages or the repair of leaks in pipes, valves or fixtures, and the removal and reinstallation of water closets, provided such repairs do not involve or require the replacement of more than one fixture or rearrangement of valves, pipes or fixtures.
- Process equipment including the associated tanks, foundations, and process piping. For combination building services/process or power piping systems the power or process piping located downstream of the control valve which separates the process from the building services piping is exempt from approval.

Section 102.10.1 Emergency Repairs

- When equipment replacements or repairs must be performed in an emergency situation, an application for approval shall be submitted within the next working business day to the building official.

Section 102.10.2 Minor Repairs

Minor repairs may be made to residential structures without application or notice to the residential building official.

Such repairs shall not include-

- Cutting away of any wall or partition.
- Removal or cutting of any structural beam or load bearing support.
- Removal or change of any required means of egress.
- Rearrangement of parts of a structure affecting the means of egress.
- Addition to, alteration to, replacement or relocation of any standpipe, water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electric wiring or mechanical or other work affecting public health or general safety.

Section 102.11.5 Building Department Jurisdictional Limitations

State Projects

Certification does not confer any jurisdiction to a certified building department to:

- The construction of buildings by the State of Ohio or on land owned by the State of Ohio including, but not limited to, its agencies, authorities, boards, commissions, administrative departments, instrumentalities, community or technical college districts, but does not include other political subdivisions.
    - Exception- Local school district building projects funded by the Ohio School Facilities Commission.
- Park districts created pursuant to Chapter 1545 of the Revised Code, except, upon approval, by resolution, of the board of park commission of the park district requesting the department to exercise that authority and conduct those activities.

Section 105 Approvals

Approvals required.

Any owner or authorized agent who intends to construct, enlarge, alter, repair, move, or change the occupancy of a residential building or structure, or portion thereof, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical, plumbing system, other residential building service equipment, or piping system the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to the residential building official of a certified residential building department and obtain the required approval.

Types of Approvals
(in addition to a full approval)

Nonconformance Approval. When residential construction documents are submitted which do not conform with the requirements of the rules of the board, such documents may be approved by the residential building official provided such nonconformance is not considered to result in a serious hazard and revised construction documents are submitted showing evidence of compliance with the applicable provisions of the rules of the board within 30 days. If not received within 30 days an adjudication order shall be issued revoking the plan approval.

Conditional Approval. When residential construction documents are submitted which cannot be approved under the other provisions of this rule, the residential building official may, at the request of the owner or owner's representative, issue a conditional plan approval when an objection to any portion of the construction documents results from conflicting interpretations of the code, or compliance requires only minor modifications to the building design. Work can proceed only up to the point where construction or materials objected to by the agency are to be incorporated into the building.

Previous Approval. The code shall not require changes in the residential construction documents, construction or designated occupancy of a structure for which a lawful approval has previously been issued or otherwise lawfully authorized, and the construction of which has been pursued in good faith within one year of the approval of the residential construction documents. One extension shall be granted for an additional year if requested by the owner at least 10 days in advance of the expiration of the approval and upon payment of any fee not to exceed $100.00.

Phased Approval. The residential building official shall issue an approval for the residential construction of foundations, floors, walls, roofs, or any other part of a building, structure, or building service equipment before the residential construction documents for the whole building, structure, or building service equipment have been submitted, provided that adequate information and detailed statements have been filed complying with applicable requirements of this code. The holder of such approval shall proceed at the holder's own risk with the building operation and without assurance that an approval for the entire structure will be granted. The holder of a phased approval may proceed only to the point for which approval has been given.

Section 105.3 Expiration

The approval of plans or drawings and specifications or data in accordance with this rule is invalid if construction, erection, alteration, or other work upon the building has not commenced within 12 months of the approval of the residential construction documents.

Section 105.5
Certificate of Plan Approval

After residential construction documents have been approved in accordance with Section 107, the residential building official shall furnish the owner/applicant a certificate of plan approval.

Required Content-

- Serial number of the certificate.
- Address where the work will occur.
- Name & address of the owner.
- Signature of the residential building official.
- Any other information as is necessary to facilitate and ensure the proper enforcement of the rules of the board.

Certificate of Plan Approval (RCO 105.5)

Office of the Building Official (City of, County of…)

Property Address:

Certificate No.

Scope of Project: **Description of proposed work**

- □ Proposed New Structure
- □ Proposed Change of Occupancy
- □ Proposed Alteration
- □ Proposed Addition
- □ Other

Owner Name / Address: *(ORC 3791.04)*

Scope of Plan Approval: **Notes**

- □ Full approval
- □ Nonconformance approval
- □ Conditional approval
- □ Previous approval
- □ Phased approval

Conditions & Variances:

Type(s) Residential Use: **Description(s)**

- □ Primary Residential Dwelling
- □ Accessory Building
- □ Deck / Patio
- □ Fence - 6' high or greater
- □ Other (Describe)

This approval is conditional upon proceeding with construction in accordance with the approved construction documents. The building official shall be notified of any changes from the approved construction documents. Such changes shall be submitted and approved by the building department prior to their implementation; Sections 105.2, 106, 107.4.2, & 107.6.1 of the Residential Code of Ohio (RCO).

The approval is invalid if construction work has not commenced within 12 months. One extension shall be granted for an additional 12-month period if requested by the owner at least 10 days in advance of the expiration of the approval and upon payment of a fee not to exceed $100.00. (RCO 105.3)

If in the course of construction, work is delayed or suspended for more than 6 months, the approval is invalid. Two extensions shall be granted for 6 months each if requested by the owner at least 10 days in advance of the expiration of the approval and upon payment of a fee for each extension of not more than $100.00. (RCO 105.4)

Fire Protection Systems: □ N/A □ Included

- □ Sprinkler
  - □ RCO 2904
  - □ NFPA 13D
  - □ NFPA 13R
  - □ NFPA 13
    - □ Limited Area
- □ Single-/Multiple-Station Smoke Alarms
- □ Carbon monoxide Alarms
- □ Integrated Alarm System
  - □ Carbon monoxide detection
  - □ Smoke Detection
- □ Other _____

This Certificate of Plan Approval is a license to build in accordance with Ohio Revised Code 3791.04.E and is issued pursuant to the provisions of RCO Sections 105 and 107.

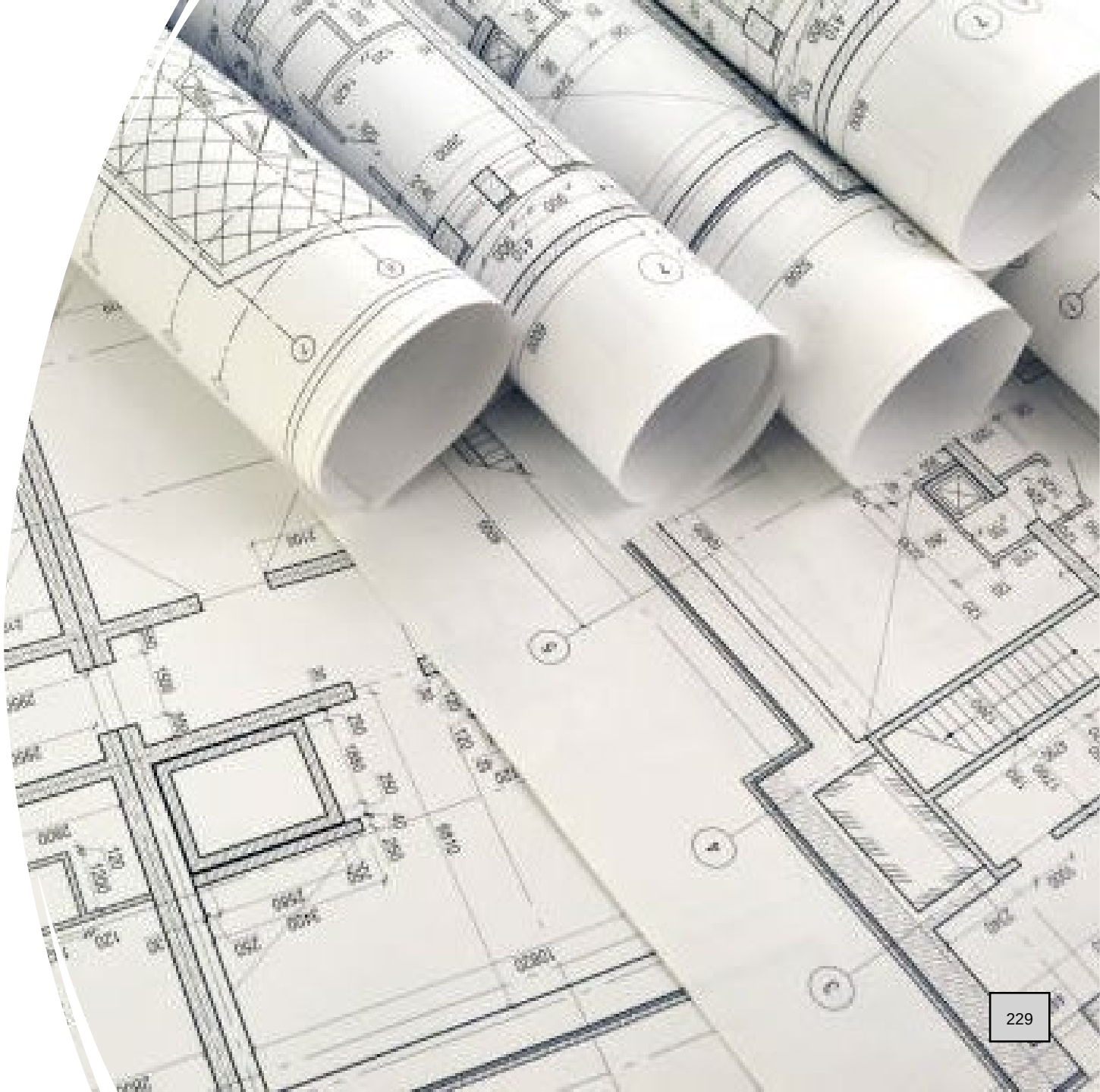
This certificate of plan approval shall be posted (RCO 107.5.2) in a conspicuous location on the site. The owner and contractor shall preserve & keep the certificate posted until all inspections have been completed and a Certificate of Occupancy is issued to the Owner.

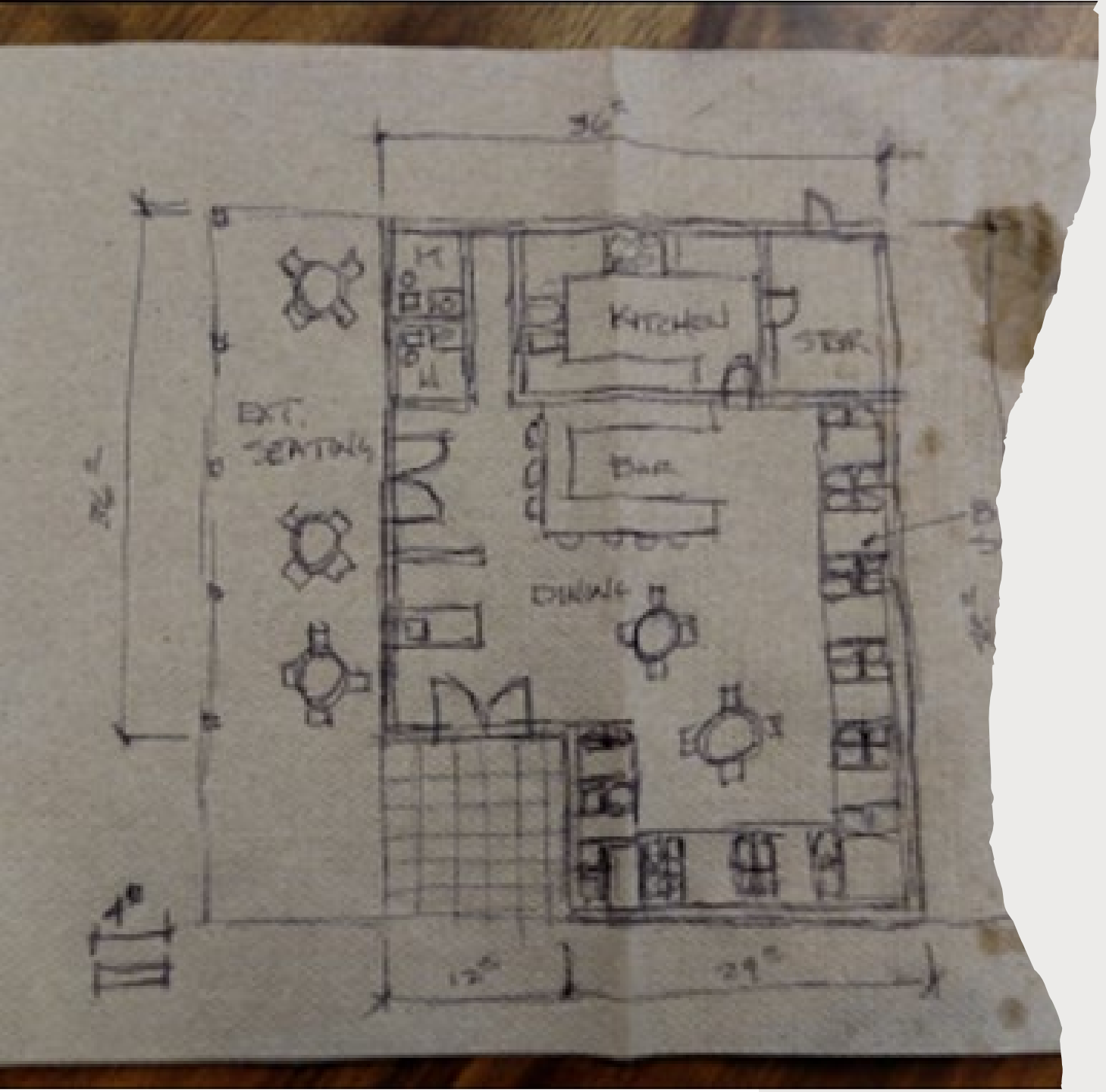
This Certificate indicates conformance with the applicable provisions of the RCO and Chapters 3781. And 3791 of the Ohio Revised Code.
Approved pursuant to the following edition of the RCO:_____

Building Official Signature Date

Section 106 Construction Documents

- Before beginning the construction of any building for which construction documents are required under Section 105, the owner or owner's representative shall submit construction documents to the residential building official for approval.
- Shall submit two or more sets with each application for plan approval.
- When construction documents are found to be in compliance with the rules of the Board, the RBO shall issue an approval.





Section 106.1.3 Construction Documents

- Construction documents shall be dimensioned and drawn upon suitable material.
- Electronic media documents are permitted if approved by the RBO.
- Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code.
- Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with this code.

Section 106.1.3 Information on Construction Documents

- Index of Drawings
- Site Plan
- Floor plans
- Exterior Wall Envelope
- Cross Sections/Wall Sections
- Structural Elements
- Fire Resistance Ratings
- System Descriptions
- Accessibility Provisions
- Additional Information

Section 106.1.4 Industrialized Units

Required documents-

- A copy of the construction documents approved by the Board; and
- Details pertaining to the on-site interconnection of modules or assemblies.

Section 106.2
Evidence of Responsibility

Required residential construction documents shall bear the identification of the person primarily responsible for their preparation.

- Does NOT have to be a registered design professional.

Section 107.2

Application for Plan Approval

To obtain plan approval, the owner or owner's representative shall first file an application in writing on a form furnished by the building department.

Such application shall:

1. Identify and describe the work to be covered.
2. Describe the land on which the proposed work is to be done, street address or similar description that will readily identify and locate the proposed building or work.
3. Be accompanied by residential construction documents.
4. Be signed by the owner or the owner's authorized agent.
5. Give such other data and information as required by the RBO.
6. Identify and clearly indicate whether the project or portion of a project intends to utilize an industrialized unit.
7. Identify and clearly indicate whether the project or portion of a project intends to utilize an assembly of individually listed or labeled products.

Section 107.2.1
Time Limit of Application

- The approval of construction documents is a license.
- Failure to approve construction documents within 30 days after filing or the disapproval of construction documents is an ‘adjudication order denying the issuance of the license’ and requiring the opportunity for an adjudication hearing.
- In accordance with Section 109, an adjudication order denying the issuance of a license shall specify the reasons for such denial.
- If an adjudication order has been issued and the owner has neither exercised the right to appeal nor resubmitted corrected documents, the application is invalid 6 months from the date of the issuance of the adjudication order.

Section 107.3 Order of Plan Review

Residential construction documents submitted for review shall be examined for compliance with the rules of the Board in the order received, unless otherwise consented to by the building owners affected by deferred examination.

Section 107.5.1
Residential Building Official Approval

When the residential construction documents have been determined to conform to the applicable provisions of the rules of the Board, the residential building official shall endorse or stamp such plans as approved and issue the certificate of plan approval.

Section 107.5.2 Posting

The certificate of plan approval shall be posted in a conspicuous location on the site. The owner and the contractor shall preserve and keep the certificate posted until the final inspections have been completed.

Section 107.6
Plan Reviews- Items of Noncompliance

107.6.1.1 Items of noncompliance shall be communicated to the owner or owner's representative and the following options shall be offered:

- 1.1 The owner will revise the construction documents and resubmit.
- 1.2 The items of noncompliance will not be brought into compliance and an adjudication order shall be issued.

107.6.1.2 The owner or owner's representative shall indicate which option will be exercised.

107.6.1.3 Notations of communications shall be made on a plan review record. The notations shall include the plans examiner's name, date of the communication with the owner or owner's representative, the observed item(s) of noncompliance, the code citation related to the item(s) of noncompliance, the action necessary to correct the item(s) of noncompliance, the option chosen by the owner or owner's representative, the name of the person communicated with, and the estimated dates of compliance & resubmission.

Section 107.6.2

In addition to the communication and determination of the options listed in Section 107.6.1, the residential building official shall also determine whether any approvals are possible, and issue the appropriate approval as described in Section 105.

- Nonconformance Approval
- Conditional Approval
- Phased Approval

Section 107.7 Approved Construction Documents

- One set of approved construction documents shall be kept by the residential building official. The other set(s) shall be returned to the applicant, kept at the work site, along with manufacturer's installation instructions and product information, and shall be available for use by the residential inspectors.

Section 108
Inspection Process

108.1

- Construction or work for which an approval is required shall be subject to inspection.
- It shall be the duty of the owner or owner's duly authorized representative to notify the residential building department when work is ready for inspection.
- It shall be the duty of the owner or owner's representative to cause the work to remain accessible and exposed for inspection purposes.
- Failure of the inspectors to inspect the work within four days (exclusive of weekends & holidays) allows the work to proceed.
- Subsequent work is allowed to proceed only to the point of the next required inspection.

Section 108.2
Required Inspections

- Lot Line Markers- all boundary lines shall be clearly marked.
- Footing & Foundations- after all forms and reinforcing steel is in place.
- Concrete Slab- after all in-slab or under-slab reinforcing steel, conduit, piping, insulation, vapor retarder, and other ancillary equipment items are in place.
- Lowest Floor Elevation- the elevation certificate required in Section 322 shall be submitted to the residential building official.
- Framing- after roof deck/sheathing, all framing, fire blocking, and bracing are in place, and all rough electric, plumbing, heating wires, pipes, chimneys, vents, and ducts are approved.

Footers

Foundations

Concrete Slabs/Floors

Lowest Floor Elevation (Flood Plain)

Rough Framing

Section 108.2
Required Inspections (Cont'd)

- Lath or Gypsum Board- after all board is hung and before joints and fasteners are taped and finished.
  - Exception- Gypsum board NOT part of a fire-resistant assembly or shear assembly.
- Fire-Resistant Penetrations- all joints & penetrations of fire-resistance-rated assemblies before concealed from view.
- Energy Efficiency- envelope insulation 'R' and 'U' values, fenestration 'U' values, duct system insulation 'R' value, infiltration air barriers, caulking/sealing of openings in envelope and ductwork, and HVAC & water heating equipment efficiencies.

Lath or Gypsum Board

Fire-Resistant Penetrations

Energy Efficiency

Section 108.2
Required Inspections (Cont'd)

- Testing of Building Service Equipment- mechanical heating & ventilation systems, mechanical exhaust systems, plumbing systems, and electrical systems shall be inspected & tested to ensure they have been installed in accordance with the approved plans, the equipment listings, and the manufacturer's installation instructions.
- Other Inspections- the residential building official is authorized to require other inspections of any residential work to ascertain compliance with the code.

Rough Electrical System

Rough Plumbing System

Rough HVAC System

Section 108.2.11
Compliance with Construction Documents

When an inspector finds that the completed work is in accordance with the approved construction documents, the inspector shall:

- Communicate the findings to the owner's on-site representative.
- Make a note of satisfactory inspection on an on-site inspection record card & inspector's log.
- Communicate the findings to the residential building official.

The residential building official shall, after review of the findings, issue the certificate of occupancy.

Section 108.4 Right of Entry

- The residential building official or his designee is authorized to enter the structure or premises at reasonable times to inspect or to perform the duties imposed by this code, provided that credentials are presented to the occupant and that entry is requested and obtained.
- Where permission to enter has not been obtained, is denied, or the residential building official has probable cause to believe a serious hazard exists in the structure, the residential building official shall proceed as required in Section 109 and shall also have recourse to the remedies provided by law to secure entry

Section 108.6 Observations of Violations, Unsafe Conditions, or Serious Hazards

- When work in connection with the location, erection, construction, repair, alteration, moving, or equipment of a residential building is contrary to the approved construction documents the residential building inspector shall proceed as required in either Section 108.6.1 or 108.7

Section 108.6.1
Communication Process for Work Contrary to Approved Construction Documents

The inspector shall communicate the nature of the differences to the owner or the owner's on-site representative and offer the following options:

- 1.1 The owner will bring the item(s) of noncompliance into compliance.
- 1.2 The owner will revise the construction documents and resubmit to the building department.
- 1.3 The items of noncompliance will not be brought into compliance and will be deferred to the residential building official for a determination as to whether an adjudication order will be issued. The residential building official shall also determine if any approvals are possible.

The owner or the owner's on-site representative shall indicate which option will be exercised.

Section 108.6.1
Communication Process for Work Contrary to Approved Construction Documents (Cont'd)

Notations shall be made on the on-site inspection record and in the inspector's log. The notations shall include:

1. The name of the inspector
2. The date of the inspection
3. The type of the inspection
4. The observed items of noncompliance
5. The name of the person communicated with
6. The estimated dates of compliance and follow-up inspection.

Section 108.6.2 Observation of Violations Not Shown on Plans

If the inspector observes a code violation that was either shown incorrectly or not adequately addressed or detailed in the approved construction documents, the inspector shall communicate the finding to the residential building official so the residential building official can make a determination as to whether the code violation is of such significance to warrant communicating the finding to the owner or the owner’s representative as a recommended change.

Section 108.6.3 Observation of Unsafe Condition or Serious Hazard

If the inspector, in the course of performing the assigned or requested inspection, observes an unsafe condition or a serious hazard, the inspector shall communicate that condition to the owner or owner's on-site representative and shall report the findings immediately to the residential building official so the building official can make a determination as to whether the violation constitutes a serious hazard which requires the issuance of an adjudication order.

Section 108.7 Determination of Noncompliance

The residential building official shall evaluate any report of items of noncompliance and render a final determination as to whether the items of noncompliance are to be communicated to the owner in the form of an adjudication order.

Section 109
Orders, Violations, and Unsafe Buildings

Section 109.1 Adjudication Orders Required

When the residential building official denies any approval or takes action in response to findings of non-compliance, such action shall be initiated by issuing an adjudication order, prior to seeking any remedy, civil or criminal.

Section 109 Orders, Violations, and Unsafe Buildings (Cont'd)

Every adjudication order shall:

- Clearly identify the section of law or rules violated.
- Specifically indicate which detail, installation, site preparation, material, appliance, device, addition, alteration to structures, residential construction documents, assemblages or procedures are necessary to change to comply with the order.
- When issued to stop work, the order shall also clearly indicate the specific work that is required to cease, when the work must cease and the conditions under which the cited work shall be permitted to resume. The order to stop work shall be given to the owner of the property involved, the owner's agent, and the person doing the work.
- Include notice of the procedure to appeal and the right to a hearing if requested within thirty days of the mailing of the order. The order shall also indicate that the owner may be represented by counsel, present arguments or contentions orally or in writing, and present evidence and examine witnesses appearing for or against the owner.
- Specify a reasonable period of time in which to bring the item(s) on the order into compliance.
- Include the signature of the residential building official.
- The order shall be sent by certified mail, return receipt requested, to the owner and any individual designated as a representative or agent by the owner in such matters.

Section 109.2 Response to Orders

- Anyone receiving an adjudication order can appeal the order (the appeal must be filed within 30 days of the mailing of the order), comply with the order, or otherwise be released from the order by the residential building official.

Office of the Residential Building Official / Name of the Department
123 Main Street
Somewhere, Ohio 43000-0000

Adjudication Order No. _____
Residential Code of Ohio, Section 109

CERTIFIED MAIL #_____

Date: June 27, 2019

Project: M.Y. Company Building
Address
City, Ohio Zip 00000

Owner/Owner's Authorized Representatives:
(Applicant)

OWNER: M.Y. Company
Address
City, Ohio Zip

(If Stop Work order issued, include the following agents per 109.1.1.(2.1)

OWNER AGENT: M.Y. Company
Address
City, Ohio Zip

CONSTRUCTION AGENT: M.Y. Company
Address
City, Ohio Zip

In response to the (Plan review completed to determine compliance with the 2013 Residential Code of Ohio for the Application for Plan Approval plan review report dated 7/1/19), or (Inspector Report indicating findings of non-compliance for inspections dated 7/21/19,) it has been determined that violation(s) exist to either of the following; to section(s) of the law or rules adopted by the Ohio Board of Building Standards pursuant to Chapters 3781 and 3791 of the Ohio Revised Code, or to the approved construction documents of the project.

The Owner is required to bring violations into compliance within _____ calendar days.

Item #	Law/rule violation *RCO Section 109.1 (1)*	Finding of Non-Compliance	Specific revision required
1	109.1.1 (1.1)	*Provide a description of the violation to Accessibility*	*Provide information /action /procedure /change to comply with the order.*
2	109.1.2(2.1)	*Specific project design element in violation within the proposed construction documents.*	*Design element to be revised and resubmitted for compliance to the Board rules.*
3	109.1.2(2.1)	*Stop Work: Specific work that shall cease (Specify time to cease)*	*Indicate conditions which the cited work shall be permitted to resume.*

Section 109.3 Prosecution & Penalties

If an owner fails to comply with Section 109.2, the owner may be prosecuted and fined up to $500.00 as provided for in Section 3791.04 of the Ohio Revised Code.

- 109.3.1 Failure to stop work after receipt of an order to stop work is hereby declared a public nuisance.

Section 109.4 Unsafe Buildings

Existing structures and equipment that are unsafe or unsanitary due to:

- Inadequate means of egress
- Inadequate light and ventilation
- Which constitutes a fire hazard
- Otherwise dangerous to human life

Shall be deemed a serious hazard.

When a residential building is found to be a serious hazard, the hazard shall be eliminated or the building shall be vacated, and if the serious hazard remains, it shall be razed

Dangerous to Human Life?

Fire Load?

Unsanitary?

Blocked Egress?

Section 110
Appeals

In order to hear and decide appeals of orders, decisions, or determinations made by the residential building official relative to the application of this code, there shall be a local appeals process established within the certified jurisdiction.

Building
Appeals Board

Section 111 Certificate of Occupancy

- No residential building or structure, in whole or in part, shall be used or occupied until the residential building official has issued an approval in the form of a certificate of occupancy or certificate of completion.

Certificate of Occupancy (RCO 111.1.1)

Office of the Building Official

(#1) **Plan Approval Application Number:**

(#2) **Property Owner Name /Address:**

(#3) **Description of structure for certificate issued:**

(#7) **Stipulations, Conditions, Variances:**

Approved As:	☐ Existing Residential Building (Condition-No Change)
☐ New Structure	☐ Partial Occupancy
☐ Addition	☐ Time-limited Occupancy
☐ Alteration	☐ Temporary Structures Occupancy

(#5) **Approved pursuant to the following editions of:**

RCO _____ OMC _____ OPC _____

(#6) **Fire Protection Systems:**

N/A ☐	Required ☐	Non-Required ☐
System Type:		Location:

This Certificate represents an approval that is valid only when the building and its facilities are used as stated and is conditional upon all building systems being maintained and tested in accordance with the applicable Ohio Board of Building Standards rules and applicable equipment or system schedules.

This certifies conformance with Chapters 3781. and 3791. of the Revised Code and the applicable provisions of the rules of the Ohio Board of Building Standards.

(#4) **Building Official:** **Date:**

Section 111.1.1
Certificate of Occupancy

The certificate of occupancy shall indicate the conditions under which the residential building shall be used. The building owner shall only use the structure in compliance with the C of O and any stated conditions.

The structure and all approved building service equipment shall be maintained in accordance with the approval.

When a residential building or structure is entitled thereto (constructed in accordance with the approved construction documents, final tests, inspections completed, and there are no outstanding orders of the building official) the residential building official shall issue a certificate of occupancy in a timely manner.

Certificate of Occupancy (cont.)

- A residential building or structure erected, enlarged, extended or altered, in whole or in part, shall not be occupied or used until a certificate of occupancy has been issued.

- Occupancy of spaces within a building which are not affected by the work shall be allowed to continue if the residential building official determines the existing spaces can be occupied safely until the completion of the work.

Section 111.1.1.3 Partial Occupancy

Upon the request of the owner or the owner's representative, a residential building official shall issue a certificate of occupancy before the completion of the entire work, provided that the residential building official determines that the space can be safely occupied prior to the full completion of the residential building, structure, or portion without endangering life or public welfare.

The certificate shall indicate the extent of the areas approved for occupancy and any time limits for the completion of the work.

Section 111.1.1.4 Time-Limited Occupancy.

A residential building or structure hereafter changed in part from one occupancy to another for a limited time may receive a C of O reflecting the time-limited occupancy provided:

1. There are no violations of law or orders of the building official pending;
2. It is established after inspection and investigation that the proposed use is not deemed to endanger public safety or welfare;
3. The residential BO has approved the use for an alternative purpose on a temporary basis;
4. The residential BO has issued a C of O indicating any special conditions under which the building or part of the building can be used for the alternative purpose within the time limit specified.

Section 111.1.1.5 Temporary Structures Occupancy

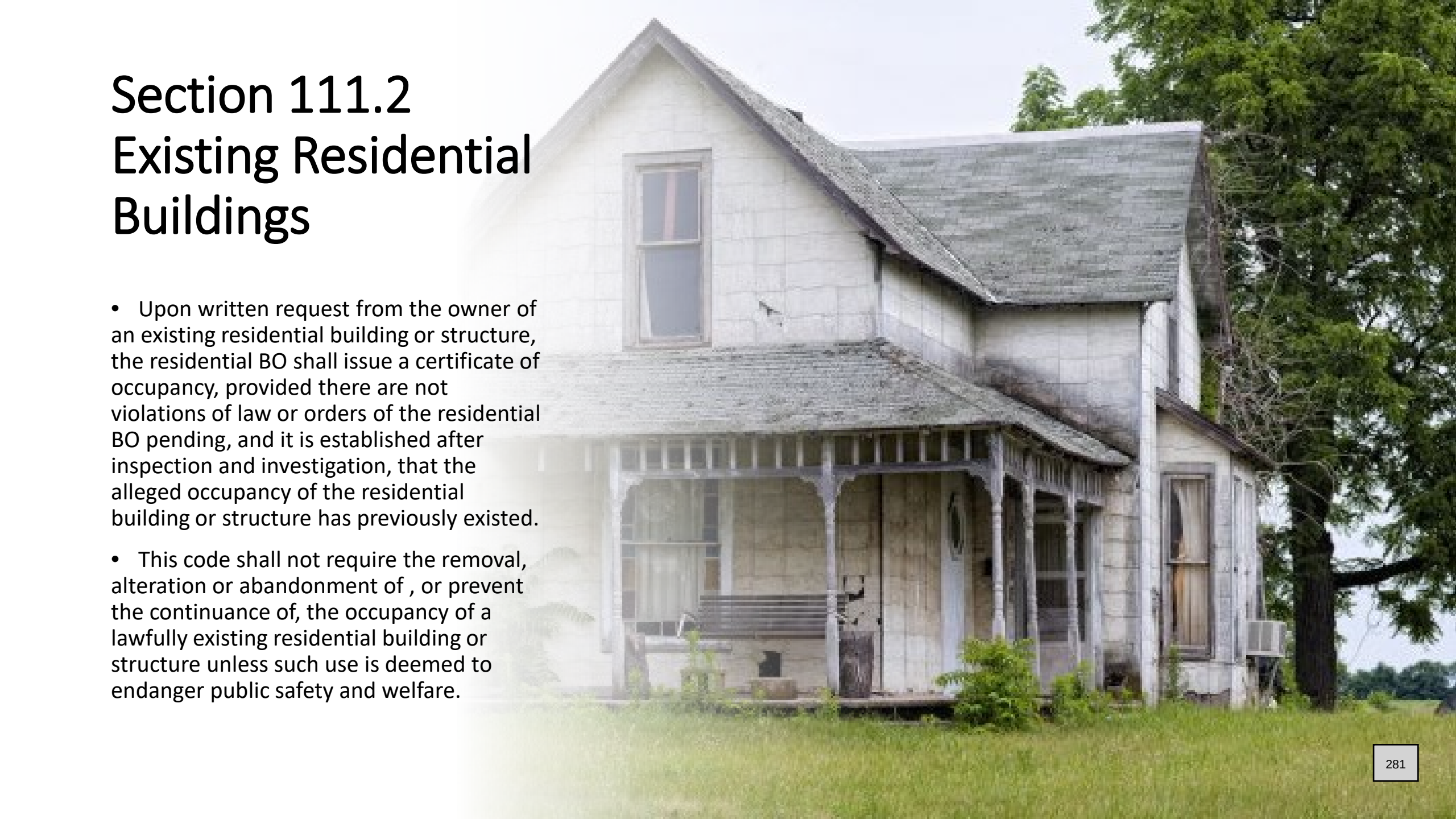
- A residential building intended to be erected, placed, and used for a period not to exceed 180 days that has been determined by the residential building official to be in compliance with Section 102.9 shall be issued a “Certificate of Occupancy for Temporary Structures”.
- The residential BO is authorized to grant extensions for demonstrated cause.

Section 111.1.2 Certificate of Completion

The certificate of completion for alterations and repairs shall indicate the conditions under which the building shall be used. The building owner shall only use the structure in accordance with the certificate of completion and any stated conditions. The structure and all approved building service equipment shall be maintained in accordance with the approval.

Section 111.2 Existing Residential Buildings

- Upon written request from the owner of an existing residential building or structure, the residential BO shall issue a certificate of occupancy, provided there are not violations of law or orders of the residential BO pending, and it is established after inspection and investigation, that the alleged occupancy of the residential building or structure has previously existed.
- This code shall not require the removal, alteration or abandonment of , or prevent the continuance of, the occupancy of a lawfully existing residential building or structure unless such use is deemed to endanger public safety and welfare.



Section 111.3 Certificate Issued

The certificate shall certify compliance with the provisions of this code, Chapters 3781 and 3791 of the Revised Code, and the purpose for which the residential building or structure may be used in its several parts.

The certificate of occupancy or certificate of completion shall contain the following:

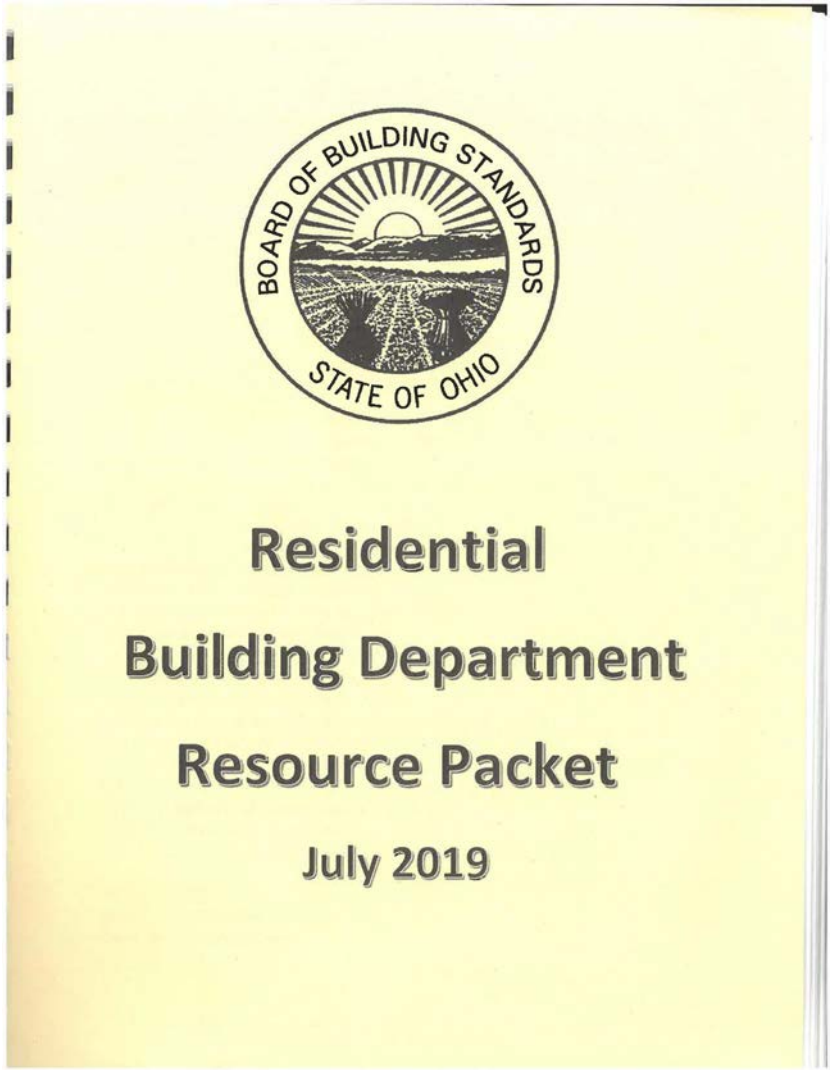
1. The plan approval application number.
2. The name and address of the owner.
3. A description of that portion of the structure for which the certificate is issued.
4. The signature of all residential building officials having jurisdiction. When more than one residential BO has jurisdiction, each shall sign the certificate with an indication of the scope of their individual approvals.
5. The edition of the residential code under which the plan approval was issued.
6. When an automatic sprinkler system is provided, the type and description of the system shall be indicated.
7. Any special stipulations and conditions of the plan approval including any variances granted to the requirements of this code.

Section 111.4
Validity of Certificate

- The certificate of occupancy and certificate of completion represent an approval that is valid only when the residential building or structure is used as approved and certifies conformance with applicable provisions of the “Residential Code of Ohio for One-, Two-, and Three-Family Dwellings” and Chapters 3781 and 3791 of the Revised Code.
- The approval is conditioned upon the building systems and equipment being maintained and tested in accordance with the approval, the “RCO”, and applicable equipment and system schedules.

RCO Resource Package

Available on Board of Building Standards website, under “Building Codes & Interpretations”.



Section 111.5
Connection of Service Utilities

- No connections shall be made from a utility, source of energy, fuel or power to any residential building or system that is regulated by this code for which a plan approval and inspections are required, until approved by the residential building official.

Section 111.6
Temporary Connection

- The residential building official shall approve the temporary connection of the residential building or system to the utility source of energy, fuel or power.

Section 113
Existing Buildings & Structures

- 113.2 Maintenance

Residential buildings, structures and the building equipment shall be maintained in a safe and sanitary condition and in accordance with the condition(s) established in any current or previous plan approvals and certificates of occupancy.

Section 113.4
Additions & Alterations

- Additions & alterations to existing buildings shall conform to the requirements of the code for new construction and shall be approved by the residential BO.
- Additions/alterations shall not be made to an existing residential building or structure which will cause the building or structure to be in violation of any provisions of this code.
- Portions of the structure not altered and not affected by the alteration are NOT required to comply with the code requirements for a new structure.
- Exception- if the work constitutes a substantial improvement in a flood hazard area.

Section 113.5
Replacement of Systems, Components & Materials

- The replacement of an existing system (egress, fire protection, mechanical, plumbing, etc.) and building components and materials not otherwise provided for in this section, shall conform to that required for new construction to the extent of the alteration.
- Existing systems, components & materials shall not be required to comply with all the requirements of this code for new construction except to the extent that they are affected by the alteration.
- Replacement of existing systems, components, & materials shall not cause them to become unsafe, hazardous, overloaded, or become less effective than what was originally installed, constructed, and/or approved.

<u>113.5.1 Door and Window Dimensions.</u>

- Minor reductions in the clear opening dimensions of replacement doors and windows that result from the use of different materials shall be allowed, whether or not they are permitted by this code.

Section 113.6
Repairs to Systems, Components, & Materials

- The repair of residential building systems, components, & materials or building components not otherwise provided for in this section, shall not be required to meet the provisions for new construction, provided such work is done in accordance with the conditions of the existing approval in the same manner and arrangement as was in the existing system, is not less safe than when originally installed, and is approved.

Section 113.7
Changes in Occupancy

- A residential building, accessory structure, or space within a residential building shall not change in its use or purpose unless it is made to comply with the requirements of this code for such use and approved by the residential building official.

- An approval is not required when the code requirements are the same for both uses.

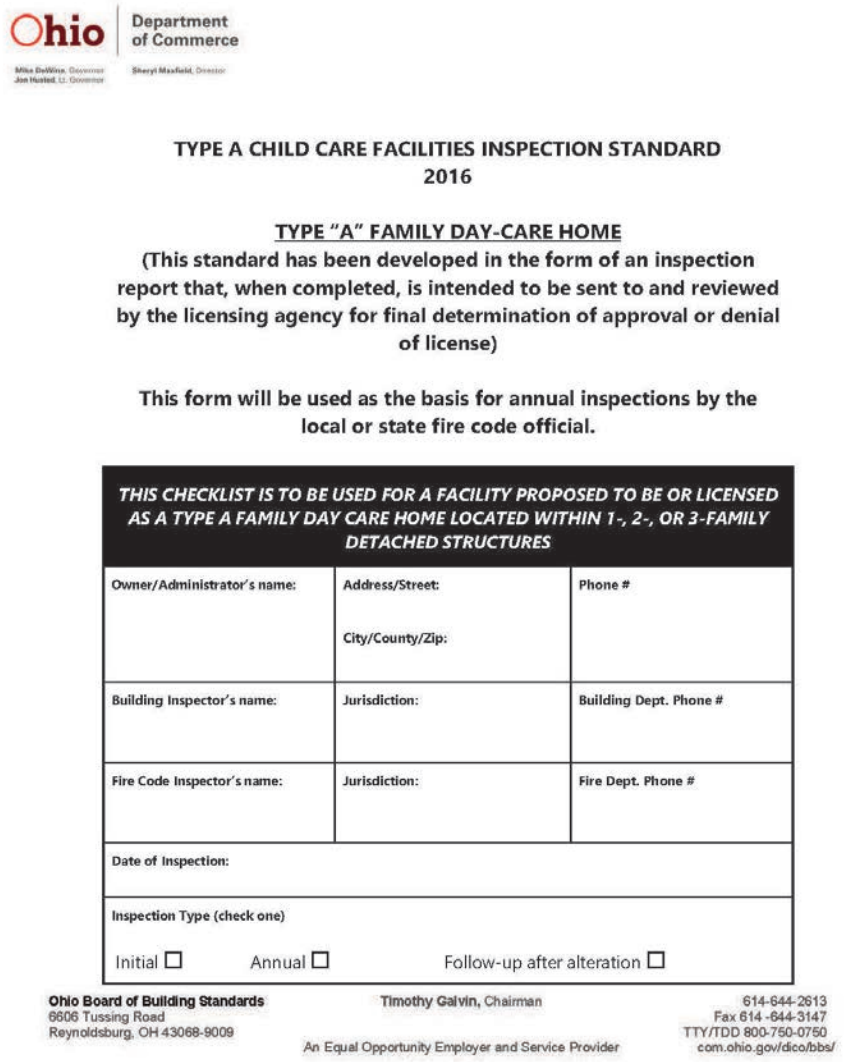
113.7.1 Use of Residential Building for Other Purpose

- No change of occupancy to uses within the scope of the OBC shall be made to any existing residential building, space within, or accessory structure unless such building is made to comply with the requirements of the OBC for such occupancy and is approved by the building official with OBC enforcement authority.

Section 113.7.2 Type A Family Day Care Homes

- A residential building that is intended to be used in whole or in part as a licensed type A family day-care home shall be inspected in accordance with the type A family day-care home checklist (available from the Board of Building Standards).

- The residential building official shall issue a report of the findings to the Ohio Department of Job and Family Services.



Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor
Sheryl Maxfield, Director

TYPE A CHILD CARE FACILITIES INSPECTION STANDARD
2016

TYPE "A" FAMILY DAY-CARE HOME
(This standard has been developed in the form of an inspection report that, when completed, is intended to be sent to and reviewed by the licensing agency for final determination of approval or denial of license)

This form will be used as the basis for annual inspections by the local or state fire code official.

THIS CHECKLIST IS TO BE USED FOR A FACILITY PROPOSED TO BE OR LICENSED AS A TYPE A FAMILY DAY CARE HOME LOCATED WITHIN 1-, 2-, OR 3-FAMILY DETACHED STRUCTURES		
Owner/Administrator's name:	Address/Street: City/County/Zip:	Phone #
Building Inspector's name:	Jurisdiction:	Building Dept. Phone #
Fire Code Inspector's name:	Jurisdiction:	Fire Dept. Phone #
Date of Inspection:		
Inspection Type (check one) Initial ☐ Annual ☐ Follow-up after alteration ☐		

Ohio Board of Building Standards
6606 Tussing Road
Reynoldsburg, OH 43068-9009

Timothy Galvin, Chairman

An Equal Opportunity Employer and Service Provider

614-644-2613
Fax 614-644-3147
TTY/TDD 800-750-0750
com.ohio.gov/dico/bbs/

Section 113.7.3
Type B Family Day-Care Home

- When a residential building that is intended to be used in whole or in part as a type B family day-care home and is required to be licensed, the residential building shall be inspected in accordance with the type B family day-care home checklist (available from the Board of Building Standards).

- The residential building official shall issue a report of the findings to the Ohio Department of Job and Family Services.

Department of Commerce

Division of State Fire Marshal

John R. Kasich, Governor
Jacqueline T. Williams, Director

Type B Child Care Facility Inspection

Owner/Administrator Name					
Address					
City		State		Zip	

Inspection Checklist

Storage is neat and orderly	☐Yes	☐No	☐NA
A fire safety and evacuation plan is prepared and maintained on site	☐Yes	☐No	☐NA
Fire drills are being performed and records are being kept for review	☐Yes	☐No	☐NA
Address numbers are in a location that is plainly legible and visible from the street/road	☐Yes	☐No	☐NA
Storage is separated from heaters or heating devices	☐Yes	☐No	☐NA
Portable unvented heaters are not being used	☐Yes	☐No	☐NA
Multiplug adapters are not being used	☐Yes	☐No	☐NA
Extension cords are not being used in place of permanent wiring	☐Yes	☐No	☐NA
Approved covers are provided for all switch and electrical outlet boxes	☐Yes	☐No	☐NA
Open wiring splices are not present	☐Yes	☐No	☐NA
"Seating furniture" complies with flammability standards	☐Yes	☐No	☐NA
Interior wall and ceiling finish and trim complies with flammability standards	☐Yes	☐No	☐NA
The single- or multiple-station smoke alarms are operable	☐Yes	☐No	☐NA
The single- or multiple-station smoke alarms are clearly audible and able to warn all occupants within all areas	☐Yes	☐No	☐NA
On each floor where child care is provided, a 2-A:10-B:C or larger portable fire extinguisher is conspicuously located within the path of egress travel	☐Yes	☐No	☐NA
If the home is **not** equipped with an automatic sprinkler system, each floor used for child care has at least two means of egress (one of the means of egress may be an emergency escape and rescue opening in accordance with the Ohio Residential Code)	☐Yes	☐No	☐NA
If the home is **not** equipped with an automatic sprinkler system, the grade level floor is connected to the other floors where child care is provided by means of an interior stairway providing a continuous enclosure resistant to the passage of smoke or an exterior stairway protected to prevent the accumulation of ice and snow	☐Yes	☐No	☐NA
All children under three years of age and all non-ambulatory children receive care on a floor with an exterior grade level access/exiting door	☐Yes	☐No	☐NA
Where two exiting means are provided, they are as remote as practicable so as to minimize the possibility that both may be blocked by fire or other emergency	☐Yes	☐No	☐NA
All exiting means are located such that the maximum distance from the most remote point on any given floor along a natural unobstructed path of travel does not exceed 100 feet	☐Yes	☐No	☐NA

Code Enforcement Bureau
8895 East Main Street
Reynoldsburg, OH 43068 U.S.A.

614 | 728 5460
Fax 614 | 728 5168
TTY/TDD 800 | 750 0750
www.com.ohio.gov

An Equal Opportunity Employer and Service Provider

What's a Type A & Type B Family Day-Care Home?

Type A Family Day-Care Homes

- A family day-care home where providers can care for 7-12 children at one time, however, each staff member can care for no more than 6 children at one time (and no more than 3 children under the age of 2).

Type B Family Day-Care Homes

- A family day-care home where providers can care for no more than 6 children at one time (and no more than 3 children under the age of 2).
- Children under 6 years of age related to the provider (including the provider's own children) and residents of the home must be included in the total group size.

Section 113.8 Moved Structures

- Residential structures moved shall be safe & sanitary and any repair, alteration, or change in occupancy shall comply with the provisions of this code for new structures.
- Field work, building location, foundations & foundation connections, wind loads, seismic loads, snow loads, and flood loads shall comply with the requirements of this code.
- The residential BO shall be authorized to inspect, or require inspection at the owner's expense, the various components of a relocated building to verify they have not sustained damage.
- Building service equipment, mechanical & plumbing shall be tested to assure they are in operating condition. Any repairs or alterations required shall be approved and completed prior to the issuance of the certificate of occupancy.
- Buildings previously approved as industrialized units, when moved after the first occupancy are to be evaluated for conformance in accordance with this section by the residential building official in the jurisdiction where the building is intended to be located.

Section 113.9 Historic Buildings

The provisions of this code relating to the construction, repair, alteration, addition, restoration and movement of residential structures, and change of occupancy shall not be mandatory for historic buildings where such residential buildings are judged by the residential building official not to constitute a distinct life safety hazard.

Section 113.10
Used Materials & Equipment

- The use of used materials which meet the requirements of this code for new materials is permitted.
- Used equipment, appliances, and devices shall not be reused unless approved by the residential building official.

Questions?

rkurtz@safebuilt.com

File Attachments for Item:

EC-2 Appliances (Independent Electrical Contractors)

EPE, ESI, RBO (4 hours)

Sean Clark

901 Beechmeadow Ln. Cincinnati, Ohio 45238
(H)513/347-9054 (C)513/800-4450
sclark@ohiovalleyelectric.com

••••••••••••••••••••••••••••

A licensed electrician with over twenty years of experience in installing, maintaining, and repairing electrical wiring, equipment, and fixtures, ensuring that work is in accordance with relevant codes, fire alarm installations, electrical control systems, and high voltage terminations. A licensed electrician with three years teaching experience in first and second year electrical.

Summary of Qualifications

- More than twenty years experience.
- Three years experience in teaching first and second year electrical.
- Thorough knowledge of electrical systems including planning additions and modifications on secondary circuits. Controls and low voltage wiring
- Able to read commercial electrical blueprints and apply NEC through the full range of commercial and industrial maintenance and construction work.
- Can use appropriate tools and diagnostic equipment to repair, install, replace, and test electrical circuits, equipment and appliances.
- Excellent ability to diagnose and repair electrical controls, industrial motor control centers, and programmable logic controllers.
- Strong desire to study and comprehend new technology.
- In-depth ability to make mathematical computations.
- Considerable ability to explain instructions and guidelines to others effectively.
- Able to assign work to employees., prioritize the work of others and organize and coordinate the work of the unit. For subs and Primes.

Professional Experience

Ohio Valley Electrical Services 2011-Present

ABC Electrical Teacher 2010-2013

Beacon Electrical Contractors 2007-2011

Ohio Valley Electrical Services 1993-2007

Electrical Superintendant/Foreman/Instructor

- First and Second year electrical instructor
- Supervision of all electrical installations of as many as 50 electricians to assure that work was done safely, efficiently, properly and within time allowed.
- Trained multiple employees in all aspects of electrical work to be able to identify an employee's strengths and weaknesses to better utilize their skills. Traced out short circuits in wiring, using test meter.
- Coordinated and implemented electrical projects within a variety of environments including plants, hospitals, schools, retail stores, public facilities, waste water treatment plants industrial buildings;

projects include both new construction and underground electrical wiring as well as renovation within existing buildings. Parking Garages and Fed Ex Ground Facilities.

- Assemble, install, test, and maintain electrical or electronic wiring, equipment, appliances, apparatus, and fixtures, using hand tools and power tools.
- Connect wires to circuit breakers, transformers, or other components.
- Construct and fabricate parts, using hand tools and specifications.
- Diagnose malfunctioning systems, apparatus, and components, using test equipment and hand tools, to locate the cause of a breakdown and correct the problem.
- Inspect electrical systems, equipment, and components to identify hazards, defects, and the need for adjustment or repair, and to ensure compliance with codes.
- Plan layout and installation of electrical wiring, equipment and fixtures, based on job specifications and local codes.
- Test electrical systems and continuity of circuits in electrical wiring, equipment, and fixtures, using testing devices such as ohmmeters, voltmeters, and oscilloscopes, to ensure compatibility and safety of system.
- Perform business management duties such as maintaining records and files, preparing reports and ordering supplies and equipment.

Education & Certifications

Master Electrician License-State of Kentucky

Journeyman Electrician's License-Hamilton, Ohio

Fire Alarm License-State of Ohio

Certified in high voltage terminations and splices

Lift, Lull, Bobcat, and Boom/scissors lift licenses

OSHA-30 card

Certified in first aid and CPR training

Certified NCCER Core Curricula Instructor

Certified NCCER Electrical Instructor

Completed 4 year apprenticeship program

1 Year Pre-apprentice school (ABC)

High School Diploma (1991)

ARCH FLASH SAFETY TRAINING

PROJECTS-SUPERVISED

$4.5mil.-MASON HIGH SCHOOL ADDITION

$250.000-3CDC-5TH RACE PARKING GARAGE

$250.000-AVONEDALE APT. COMPLEX

$100.000-MAHOGANYS AT THE BANK-

1.2mil. -PATHEON CHEMICALS

$450.000- FED EX GROUND ADDITION

$250.000-LIBERTY WAY PROJECT

$500.000-GE AT THE BANKS

$100.000 - SYCAMORE SCHOOLS/POWER/CONTROL-

$50.000 - NKU RETROFIT

$250.000- UC POWER PLANT ADDITION

$75.000 - 580BLD/ CHEMED, RETROFIT

$4.0mil - DHL- CONVEYERS/SHELL

$90.000- DOUBLE TREE AIRPORT

$2.5mil- TWIN LAKES OF MONTGOMERY

$45.000- STEINMART ANDERSON

And many small T&M jobs.

All on time and under budget

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Kevin Collins (Contact Name)
Organization: IEC of Greater Cincinnati (Organization/Company)
Address: 586 Kings Run Drive (Include Room Number, Suite, etc.)
City: Cincinnati State: OH Zip: 45232
E-Mail: KCollins@iec-cincy.com
Telephone: 513-542-0400 Fax: —
Course Sponsor: IEC of Greater Cincinnati

COURSE INFORMATION:

Course Title: Appliances

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number:

Purpose and Objective: Review article 422 of the NEC. We will cover requirements for dishwashers, disposals, water heaters, central vac systems, ranges & dryers. We will also calculate the load required to the service size.

Number of Instructional Contact Hours that can be obtained upon completion: 4

If Multi-Session, Number of Instructional Contact Hours Per Session: —

Program Applicable for the Following Participants:

Building Official ☐	Master Plans Examiner ☐	Building Inspector ☐	Fire Protection Inspector ☐	Mechanical Inspector ☐	
	Plumbing Plans Exam. ☐			Plumbing Inspector ☐	
	Electrical Plans Exam. ☒			Non-Res IU Inspector ☐	
	Mechanical Plans Exam. ☐				
Res Building Official ☒	Res Plans Examiner ☐	Res Building Inspector ☐	Res Mechanical Inspector ☐	Res IU Inspector ☐	

Electrical Safety Inspectors ☒
Location of ESI Course: IEC of Greater Cincinnati Date(s) of ESI Course(s): 2/1/23

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
Course Sponsor:	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:	Copy of quizzes or tests to be given	
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Special Equipment Chapter 6

Appliances 422, 220

Special Equipment

- Chapter 6
- Equipment that are not your everyday items but you will come across from time to time
  - Not receptacles, switches, panels, light fixtures
- Not the structure themselves

Most sections are small (except pools)

Special Equipment

- Chapter 6 – not many questions
- Examples
  - Signs
  - Elevators
  - Welders
  - Pools

Use the index!

Special Equipment

A hot tub installed indoors shall have at least one 125-volt, 15 or 20 ampere receptacle on a general purpose branch circuit located not less than ____ feet from, and not exceeding ____ feet from, the inside wall of the hot tub:

A. 3, 8
B. 6,10
C. 6,12
D. 8,20

Special Equipment

A hot tub installed indoors shall have at least one 125-volt, 15 or 20 ampere receptacle on a general purpose branch circuit located not less than ____ feet from, and not exceeding ____ feet from, the inside wall of the hot tub.

A. 3, 8

B. 6,10

C. 6,12

D. 8,20

680.43(A)

Special Equipment

- Branch circuits that supply neon tubing installations shall be rated not to exceed ____ amps:

A. 15
B. 20
C. 30
D. 40

Special Equipment

Branch circuits that supply neon tubing installations shall be rated not to exceed ____ amps.

A. 15

B. 20

C. 30

D. 40

600.5 (B)(1)

Appliances

- 422
  - Infrared heating appliances (heat lamps)
  - Non motor appliance – water heater
  - Central Vac
  - Dishwasher
  - Trash compactor
  - Range hoods
- You won't find specific appliances in index!
- Not the big appliances – Ranges and Dryers

Appliances

- 424, 426, 427
  - Deals with heating equipment
    - Minimal questions

Appliances

- The length of cord of a trash compactor is allowed to be:

A. 2 feet
B. 3 feet
C. 6 feet
D. Any of these

Appliances

- The length of cord of a trash compactor is allowed to be:

A. 2 feet

B. 3 feet

C. 6 feet

D. Any of these

422.16 (B) (2) (2)

Table 220.54 Demand Factors for Household Electric Clothes Dryers

Number of Dryers	Demand Factor (Percent)
1–4	100%
5	85%
6	75%
7	65%
8	60%
9	55%
10	50%
11	47%
12–22	% = 47 – (number of dryers – 11)
23	35%
24–42	% = 35 – [0.5 × (number of dryers – 23)]
43 and over	25%

Dryer

- Dryers are calculated at the greater of
  - 5,000 W
  - The nameplate rating

Demand factors can be applied from 220.54

Ex: I have 5 – 4,500 W Dryers, what is the service demand?

5,000 (minimum required) x 5 x .85 = 21,250 W

This is only for service,
branch is computed separately

Number of Appliances	Demand Factor (Percent) (See Notes)		Column C Maximum Demand (kW) (See Notes) (Not over 12 kW Rating)
	Column A (Less than 3½ kW Rating)	Column B (3½ kW to 8¼ kW Rating)	
1	80	80	8
2	75	65	11
3	70	55	14
4	66	50	17
5	62	45	20
6	59	43	21
7	56	40	22
8	53	36	23
9	51	35	24
10	49	34	25
11	47	32	26
12	45	32	27
13	43	32	28
14	41	32	29
15	40	32	30
16	39	28	31
17	38	28	32
18	37	28	33
19	36	28	34
20	35	28	35
21	34	26	36
22	33	26	37
23	32	26	38
24	31	26	39
25	30	26	40
26–30	30	24	15 kW + 1 kW for each range
31–40	30	22	
41–50	30	20	25 kW + ¾ kW for each range
51–60	30	18	
61 and over	30	16	

Electric Ranges

- 220.55
- For dwelling with no additional information
  - Use 8,000 W
- If you know the kW use the appropriate column
- Column C is already in kW
- Column A and B are percentages

Electric Ranges

What is the demand factor for 6 – 10kW ranges?

Number of appliances = 6

The ranges would fall into Column C

21 kW would be the demand factor

Electric Ranges

What is the demand factor for 5 – 7 kW ranges?

5 x 7,000W (given) = 35,000W

35,000W x 45% = **15,750W**

If the ranges exceed 12 kW or if the ranges fall into different columns – see me later or D.6 in the examples in the back of the book

Electric Ranges

- What is the demand factor for 12 – 2kW ranges?
- What is the demand factor for 7 - 11 kW ranges?

Electric Ranges

- What is the demand factor for 12 –2kW ranges?
  - Use column A
    - Your percentage will be 45%
  - 12 x 2 kW = 24 kW
  - 24kW x 45% (.45) = 10.8 kW or 10,800W (VA)
- What's the demand factor for 7 -11 kW ranges?
  - Use column C
  - 22 kW

Ranges – article 220.55
Calculating the service load for range(s)

Dryers – article 220.54
Calculating the service load for dryer(s)

Article 422
In Sink Waste Disposals
Dishwashers
Range Hoods
Central Vacuums
Water Heaters

File Attachments for Item:

EC-3 Box Fill (Independent Electrical Contractors)

EPE, ESI, RBO (4 hours)

Box Fill – 314.16 (A) and (B)

- Number of conductors of the same size in different boxes.
- Number of conductors of different sizes in different boxes.
- Other factors in determining box fill
  - Wire spliced/running straight through
  - Clamps
    - Internal/External
  - Devices
  - Grounds (Regular/Isolated)

Sean Clark

901 Beechmeadow Ln. Cincinnati, Ohio 45238

(H)513/347-9054 (C)513/800-4450

sclark@ohiovalleyelectric.com

••••••••••••••••••••••••••••

A licensed electrician with over twenty years of experience in installing, maintaining, and repairing electrical wiring, equipment, and fixtures, ensuring that work is in accordance with relevant codes, fire alarm installations, electrical control systems, and high voltage terminations. A licensed electrician with three years teaching experience in first and second year electrical.

Summary of Qualifications

- More than twenty years experience.
- Three years experience in teaching first and second year electrical.
- Thorough knowledge of electrical systems including planning additions and modifications on secondary circuits. Controls and low voltage wiring
- Able to read commercial electrical blueprints and apply NEC through the full range of commercial and industrial maintenance and construction work.
- Can use appropriate tools and diagnostic equipment to repair, install, replace, and test electrical circuits, equipment and appliances.
- Excellent ability to diagnose and repair electrical controls, industrial motor control centers, and programmable logic controllers.
- Strong desire to study and comprehend new technology.
- In-depth ability to make mathematical computations.
- Considerable ability to explain instructions and guidelines to others effectively.
- Able to assign work to employees., prioritize the work of others and organize and coordinate the work of the unit. For subs and Primes.

Professional Experience

Ohio Valley Electrical Services 2011-Present

ABC Electrical Teacher 2010-2013

Beacon Electrical Contractors 2007-2011

Ohio Valley Electrical Services 1993-2007

Electrical Superintendant/Foreman/Instructor

- First and Second year electrical instructor
- Supervision of all electrical installations of as many as 50 electricians to assure that work was done safely, efficiently, properly and within time allowed.
- Trained multiple employees in all aspects of electrical work to be able to identify an employee's strengths and weaknesses to better utilize their skills. Traced out short circuits in wiring, using test meter.
- Coordinated and implemented electrical projects within a variety of environments including plants, hospitals, schools, retail stores, public facilities, waste water treatment plants industrial buildings;

projects include both new construction and underground electrical wiring as well as renovation within existing buildings. Parking Garages and Fed Ex Ground Facilities.

- Assemble, install, test, and maintain electrical or electronic wiring, equipment, appliances, apparatus, and fixtures, using hand tools and power tools.
- Connect wires to circuit breakers, transformers, or other components.
- Construct and fabricate parts, using hand tools and specifications.
- Diagnose malfunctioning systems, apparatus, and components, using test equipment and hand tools, to locate the cause of a breakdown and correct the problem.
- Inspect electrical systems, equipment, and components to identify hazards, defects, and the need for adjustment or repair, and to ensure compliance with codes.
- Plan layout and installation of electrical wiring, equipment and fixtures, based on job specifications and local codes.
- Test electrical systems and continuity of circuits in electrical wiring, equipment, and fixtures, using testing devices such as ohmmeters, voltmeters, and oscilloscopes, to ensure compatibility and safety of system.
- Perform business management duties such as maintaining records and files, preparing reports and ordering supplies and equipment.

Education & Certifications

Master Electrician License-State of Kentucky

Journeyman Electrician's License-Hamilton, Ohio

Fire Alarm License-State of Ohio

Certified in high voltage terminations and splices

Lift, Lull, Bobcat, and Boom/scissors lift licenses

OSHA-30 card

Certified in first aid and CPR training

Certified NCCER Core Curricula Instructor

Certified NCCER Electrical Instructor

Completed 4 year apprenticeship program

1 Year Pre-apprentice school (ABC)

High School Diploma (1991)

ARCH FLASH SAFETY TRAINING

PROJECTS-SUPERVISED

$4.5mil.-MASON HIGH SCHOOL ADDITION

$250.000-3CDC-5TH RACE PARKING GARAGE

$250.000-AVONEDALE APT. COMPLEX

$100.000-MAHOGANYS AT THE BANK-

1.2mil. -PATHEON CHEMICALS

$450.000- FED EX GROUND ADDITION

$250.000-LIBERTY WAY PROJECT

$500.000-GE AT THE BANKS

$100.000 - SYCAMORE SCHOOLS/POWER/CONTROL-

$50.000 - NKU RETROFIT

$250.000- UC POWER PLANT ADDITION

$75.000 - 580BLD/ CHEMED, RETROFIT

$4.0mil - DHL- CONVEYERS/SHELL

$90.000- DOUBLE TREE AIRPORT

$2.5mil- TWIN LAKES OF MONTGOMERY

$45.000- STEINMART ANDERSON

And many small T&M jobs.

All on time and under budget

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Kevin Collins (Contact Name)
Organization: IEC of Greater Cincinnati (Organization/Company)
Address: 586 Kings Run Drive (Include Room Number, Suite, etc.)
City: Cincinnati State: OH Zip: 45232
E-Mail: KCollins@iec-cincy.com
Telephone: 513-542-0400 Fax: —
Course Sponsor: IEC of Greater Cincinnati

COURSE INFORMATION:

Course Title: Box Fill

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: Review article 314 of the NEC. We will calculate the type of box as well as the minimum size required based of number of conductors, size of conductors & devices/clamps contained in the box.

Number of Instructional Contact Hours that can be obtained upon completion: 4

If Multi-Session, Number of Instructional Contact Hours Per Session: —

Program Applicable for the Following Participants:

Building Official ☐ Master Plans Examiner ☐ Plumbing Plans Exam. ☐ Electrical Plans Exam. ☒ Mechanical Plans Exam. ☐ Building Inspector ☐ Fire Protection Inspector ☐ Mechanical Inspector ☐ Plumbing Inspector ☐ Non-Res IU Inspector ☐

Res Building Official ☒ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☒
Location of ESI Course: IEC of Greater Cincinnati Date(s) of ESI Course(s): 11/30/22

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
Course Sponsor:	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:	Copy of quizzes or tests to be given	
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Box Fill
314.16

Box Fill

- 314.16(A) & (B)

314.4 Metal Boxes. Metal boxes shall be grounded and bonded in accordance with Parts I, IV, V, VI, VII, and X of Article 250 as applicable, except as permitted in 250.112(I).

II. Installation

314.15 Damp or Wet Locations. In damp or wet locations, boxes, conduit bodies, and fittings shall be placed or equipped so as to prevent moisture from entering or accumulating within the box, conduit body, or fitting. Boxes, conduit bodies, and fittings installed in wet locations shall be listed for use in wet locations. Approved drainage openings not larger than 6 mm (¼ in.) shall be permitted to be installed in the field in boxes or conduit bodies listed for use in damp or wet locations. For installation of listed drain fittings, larger openings are permitted to be installed in the field in accordance with manufacturer's instructions.

Informational Note No. 1: For boxes in floors, see 314.27(B).

Informational Note No. 2: For protection against corrosion, see 300.6.

314.16 Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies. Boxes and conduit bodies shall be of an approved size to provide free space for all enclosed conductors. In no case shall the volume of the box, as calculated in 314.16(A), be less than the fill calculation as calculated in 314.16(B). The minimum volume for conduit bodies shall be as calculated in 314.16(C).

The provisions of this section shall not apply to terminal housings supplied with motors or generators.

Informational Note: For volume requirements of motor or generator terminal housings, see 430.12.

Boxes and conduit bodies enclosing conductors 4 AWG or larger shall also comply with the provisions of 314.28.

(A) Box Volume Calculations. The volume of a wiring enclosure (box) shall be the total volume of the assembled sections and, where used, the space provided by plaster rings, domed covers, extension rings, and so forth, that are marked with their volume or are made from boxes the dimensions of which are listed in Table 314.16(A).

(1) Standard Boxes. The volumes of standard boxes that are not marked with their volume shall be as given in Table 314.16(A).

(2) Other Boxes. Boxes 1650 cm^3 (100 $in.^3$) or less, other than those described in Table 314.16(A), and nonmetallic boxes shall be durably and legibly marked by the manufacturer with their volume. Boxes described in Table 314.16(A) that have a volume larger than is designated in the table shall be permitted to have their volume marked as required by this section.

(B) Box Fill Calculations. The volumes in paragraphs 314.16(B)(1) through (B)(5), as applicable, shall be added together. No allowance shall be required for small fittings such as locknuts and bushings.

(1) Conductor Fill. Each conductor that originates outside the box and terminates or is spliced within the box shall be counted once, and each conductor that passes through the box without splice or termination shall be counted once. Each loop or coil of unbroken conductor not less than twice the minimum length required for free conductors in 300.14 shall be counted twice. The conductor fill shall be calculated using Table 314.16(B). A conductor, no part of which leaves the box, shall not be counted.

Exception: An equipment grounding conductor or conductors or not over four fixture wires smaller than 14 AWG, or both, shall be permitted to be omitted from the calculations where they enter a box from a domed luminaire or similar canopy and terminate within that box.

(2) Clamp Fill. Where one or more internal cable clamps, whether factory or field supplied, are present in the box, a single volume allowance in accordance with Table 314.16(B) shall be made based on the largest conductor present in the box. No allowance shall be required for a cable connector with its clamping mechanism outside the box.

A clamp assembly that incorporates a cable termination for the cable conductors shall be listed and marked for use with specific nonmetallic boxes. Conductors that originate within the clamp assembly shall be included in conductor fill calculations covered in 314.16(B)(1) as though they entered from outside the box. The clamp assembly shall not require a fill allowance, but the volume of the portion of the assembly that remains within the box after installation shall be excluded from the box volume as marked in 314.16(A)(2).

(3) Support Fittings Fill. Where one or more luminaire studs or hickeys are present in the box, a single volume allowance in accordance with Table 314.16(B) shall be made for each type of fitting based on the largest conductor present in the box.

(4) Device or Equipment Fill. For each yoke or strap containing one or more devices or equipment, a double volume allowance in accordance with Table 314.16(B) shall be made for each yoke or strap based on the largest conductor connected to a device(s) or equipment supported by that yoke or strap. A device or utilization equipment wider than a single 50 mm (2 in.) device box as described in Table 314.16(A) shall have double volume allowances provided for each gang required for mounting.

(5) Equipment Grounding Conductor Fill. Where one or more equipment grounding conductors or equipment bonding jumpers enter a box, a single volume allowance in accordance with Table 314.16(B) shall be made based on the largest

Table 314.16(A) Metal Boxes

Box Trade Size			Minimum Volume		Maximum Number of Conductors* (arranged by AWG size)						
mm	in.		cm^3	$in.^3$	18	16	14	12	10	8	6
100 × 32	(4 × 1¼)	round/octagonal	205	12.5	8	7	6	5	5	5	2
100 × 38	(4 × 1½)	round/octagonal	254	15.5	10	8	7	6	6	5	3
100 × 54	(4 × 2⅛)	round/octagonal	353	21.5	14	12	10	9	8	7	4
100 × 32	(4× 1¼)	square	295	18.0	12	10	9	8	7	6	3
100 × 38	(4 × 1½)	square	344	21.0	14	12	10	9	8	7	4
100 × 54	(4 × 2⅛)	square	497	30.3	20	17	15	13	12	10	6
120 × 32	(4 11/16 × 1¼)	square	418	25.5	17	14	12	11	10	8	5
120 × 38	(4 11/16 × 1½)	square	484	29.5	19	16	14	13	11	9	5
120 × 54	(4 11/16 × 2⅛)	square	689	42.0	28	24	21	18	16	14	8
75 × 50 × 38	(3 × 2 × 1½)	device	123	7.5	5	4	3	3	3	2	1
75 × 50 × 50	(3 × 2 × 2)	device	164	10.0	6	5	5	4	4	3	2
75× 50 × 57	(3× 2 × 2¼)	device	172	10.5	7	6	5	4	4	3	2
75 × 50 × 65	(3 × 2 × 2½)	device	205	12.5	8	7	6	5	5	4	2
75 × 50 × 70	(3 × 2 × 2¾)	device	230	14.0	9	8	7	6	5	4	2
75 × 50 × 90	(3 × 2 × 3½)	device	295	18.0	12	10	9	8	7	6	3
100 × 54 × 38	(4 × 2⅛ × 1½)	device	169	10.3	6	5	5	4	4	3	2
100 × 54 × 48	(4 × 2⅛ × 1⅞)	device	213	13.0	8	7	6	5	5	4	2
100 × 54 × 54	(4 × 2⅛ × 2⅛)	device	238	14.5	9	8	7	6	5	4	2
95 × 50 × 65	(3¾ × 2 × 2½)	masonry box/gang	230	14.0	9	8	7	6	5	4	2
95 × 50 × 90	(3¾ × 2 × 3½)	masonry box/gang	344	21.0	14	12	10	9	8	7	4
min. 44.5 depth	FS — single cover/gang (1¾)		221	13.5	9	7	6	6	5	4	2
min. 60.3 depth	FD — single cover/gang (2⅜)		295	18.0	12	10	9	8	7	6	3
min. 44.5 depth	FS — multiple cover/gang (1¾)		295	18.0	12	10	9	8	7	6	3
min. 60.3 depth	FD — multiple cover/gang (2⅜)		395	24.0	16	13	12	10	9	8	4

*Where no volume allowances are required by 314.16(B)(2) through (B)(5).

Table 314.16(B) Volume Allowance Required per Conductor

Size of Conductor (AWG)	Free Space Within Box for Each Conductor	
	cm^3	$in.^3$
18	24.6	1.50
16	28.7	1.75
14	32.8	2.00
12	36.9	2.25
10	41.0	2.50
8	49.2	3.00
6	81.9	5.00

equipment grounding conductor or equipment bonding jumper present in the box. Where an additional set of equipment grounding conductors, as permitted by 250.146(D), is present in the box, an additional volume allowance shall be made based on the largest equipment grounding conductor in the additional set.

(C) Conduit Bodies.

(1) General. Conduit bodies enclosing 6 AWG conductors or smaller, other than short-radius conduit bodies as described in 314.16(C)(3), shall have a cross-sectional area not less than twice the cross-sectional area of the largest conduit or tubing to which they can be attached. The maximum number of conductors permitted shall be the maximum number permitted by Table 1 of Chapter 9 for the conduit or tubing to which it is attached.

(2) With Splices, Taps, or Devices. Only those conduit bodies that are durably and legibly marked by the manufacturer with their volume shall be permitted to contain splices, taps, or devices. The maximum number of conductors shall be calculated in accordance with 314.16(B). Conduit bodies shall be supported in a rigid and secure manner.

(3) Short Radius Conduit Bodies. Conduit bodies such as capped elbows and service-entrance elbows that enclose conductors 6 AWG or smaller, and are only intended to

Box fill

- 314.16 (A) – simpler chart – metal boxes
- 314.16 (B) - needed when wire sizes are different and factors other than conductors are involved (clamps, devices)
- If conductors are #4 and larger shall also comply with 314.28 (see 314.16)
- 314.17 (C) Non metallic boxes
  - Exception – within 8” of the box

Box fill

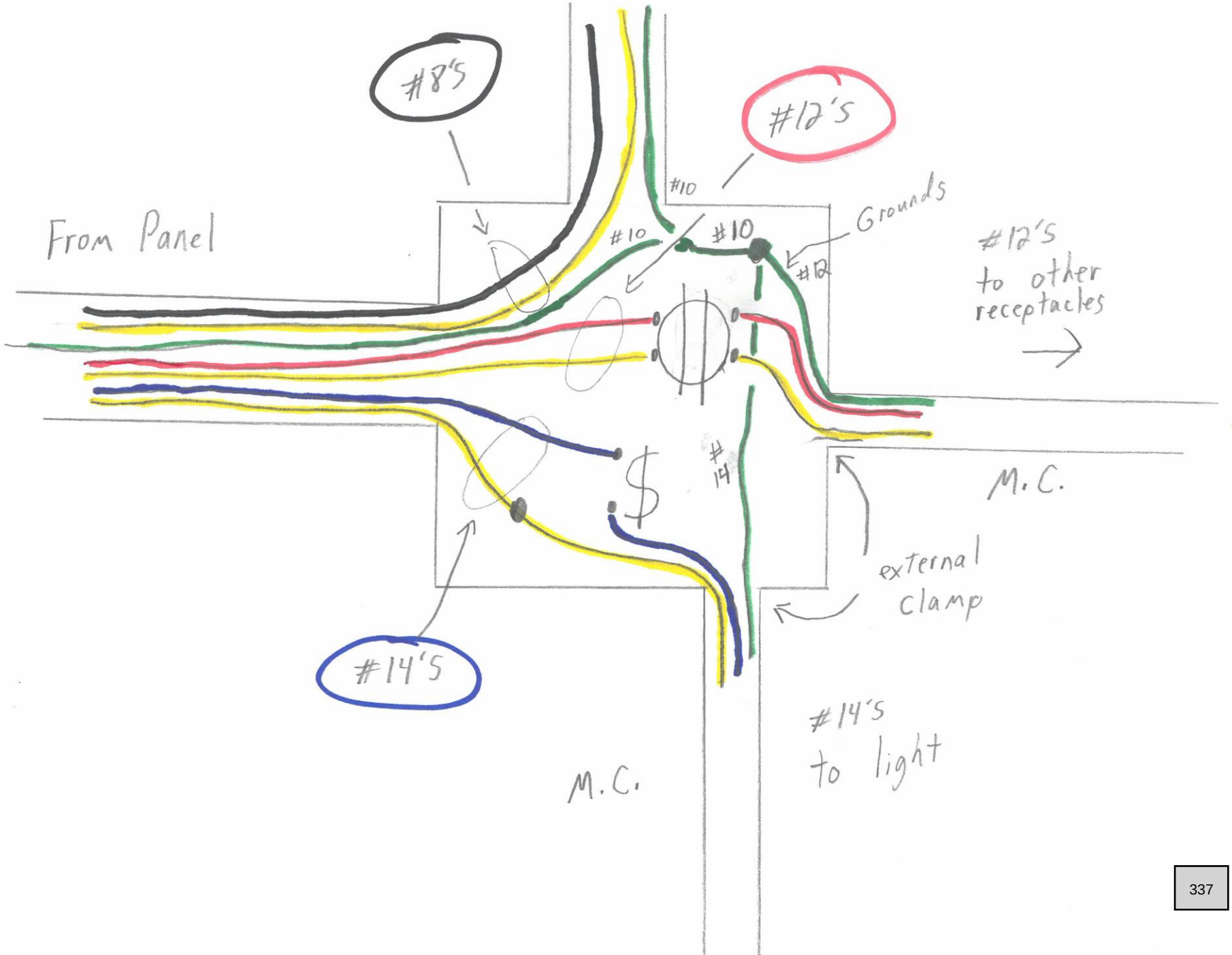
- How many #12 can fit into a 3x2x2 device box?
- How many #8 can fit into a 4 x 2 1/8 round box?

Box fill

- How many #12 can fit into a 3x2x2 device box?
  - **4**
- How many #8 can fit into a 4 x 2 1/8 round box?
  - **7**
    - Make sure boxes match exactly.

Box Fill – 314.16 (B)

- Wires passing through count once
- Fixture wires smaller than #14 do not count
- Internal clamp – counted once no matter how many – based on largest conductor in box
  - External connectors do not count
- Support fittings – counted once no matter how many – based on largest conductor size
- Devices or equipment yoke – count twice for each one based on largest wire size going to device
- Equipment grounds – No matter how many grounds, only 1 (based on largest ground) shall be counted
  - Equipment ground calculation has been revised in 2020.


#8's
#12's
#10
From Panel
#10
#10
Grounds
#12
#12's
to other
receptacles
#14
M.C.
external
clamp
#14's
M.C.
#14's
to light

Box Fill

I have a raceway coming from a panel and terminating into a box.

In the box I have

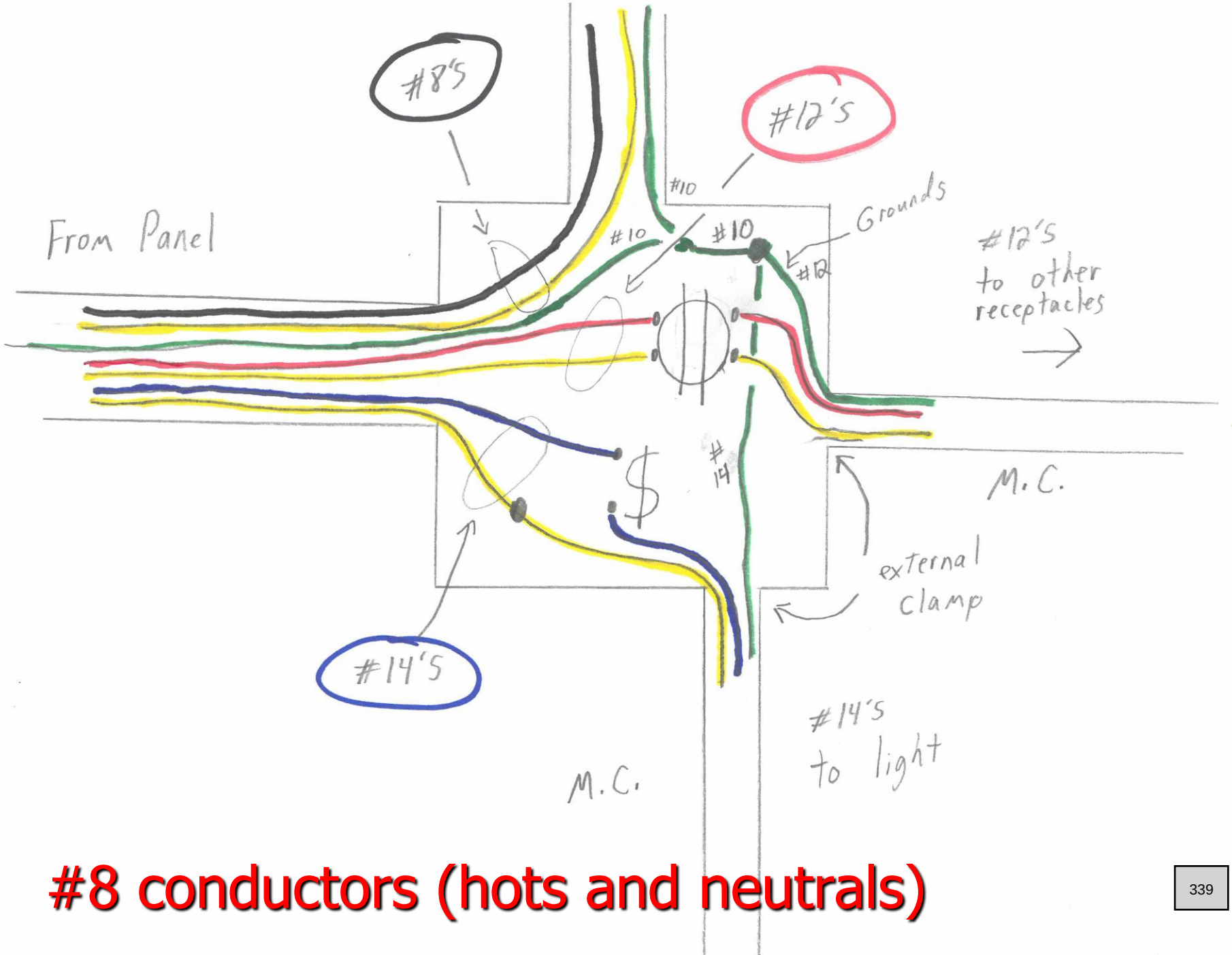
2 - #8's passing straight through

A #12 ungrounded and grounded conductor landing on a receptacle and then leaving the box to pick up other receptacles.

A #14 ungrounded and grounded conductor enter the box. The "hot" lands on the line side of a switch. A "hot" then leaves the switch heading toward a light. The neutral is spliced and heads towards the light.

A #10 ground enters the box. It is spliced with a #14 and #12. The #14 heads off toward the light, the #12 heads off to the other receptacles.

The cables heading toward the other receptacle and the light have external clamps.

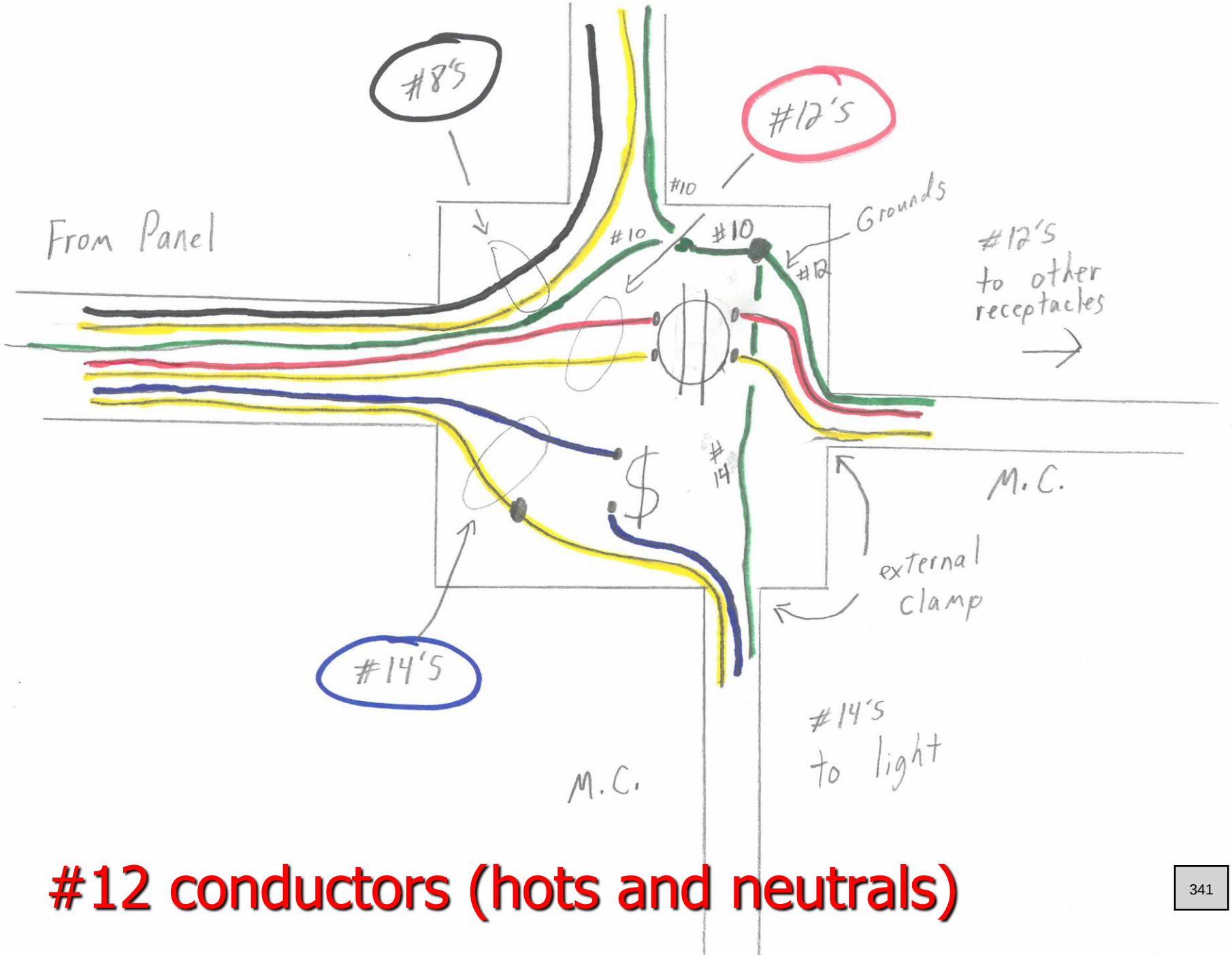


#8 conductors (hots and neutrals)

Box Fill

- 2 - #8's pass straight through
- The volume allowance for a #8 is 3 in cubed

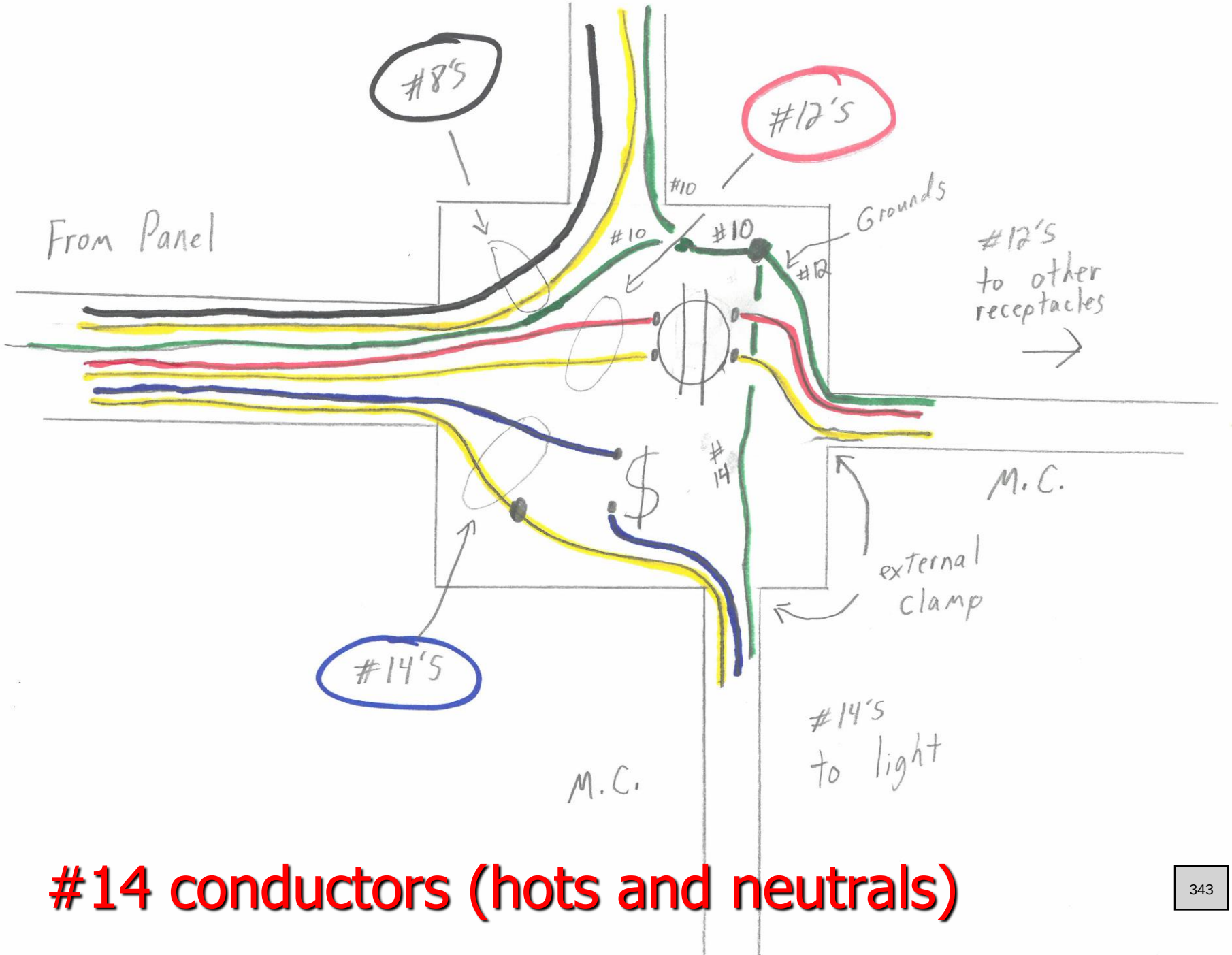
- 2 x 3 = 6
  - This is your volume of your number #8's



#12 conductors (hots and neutrals)

Box Fill

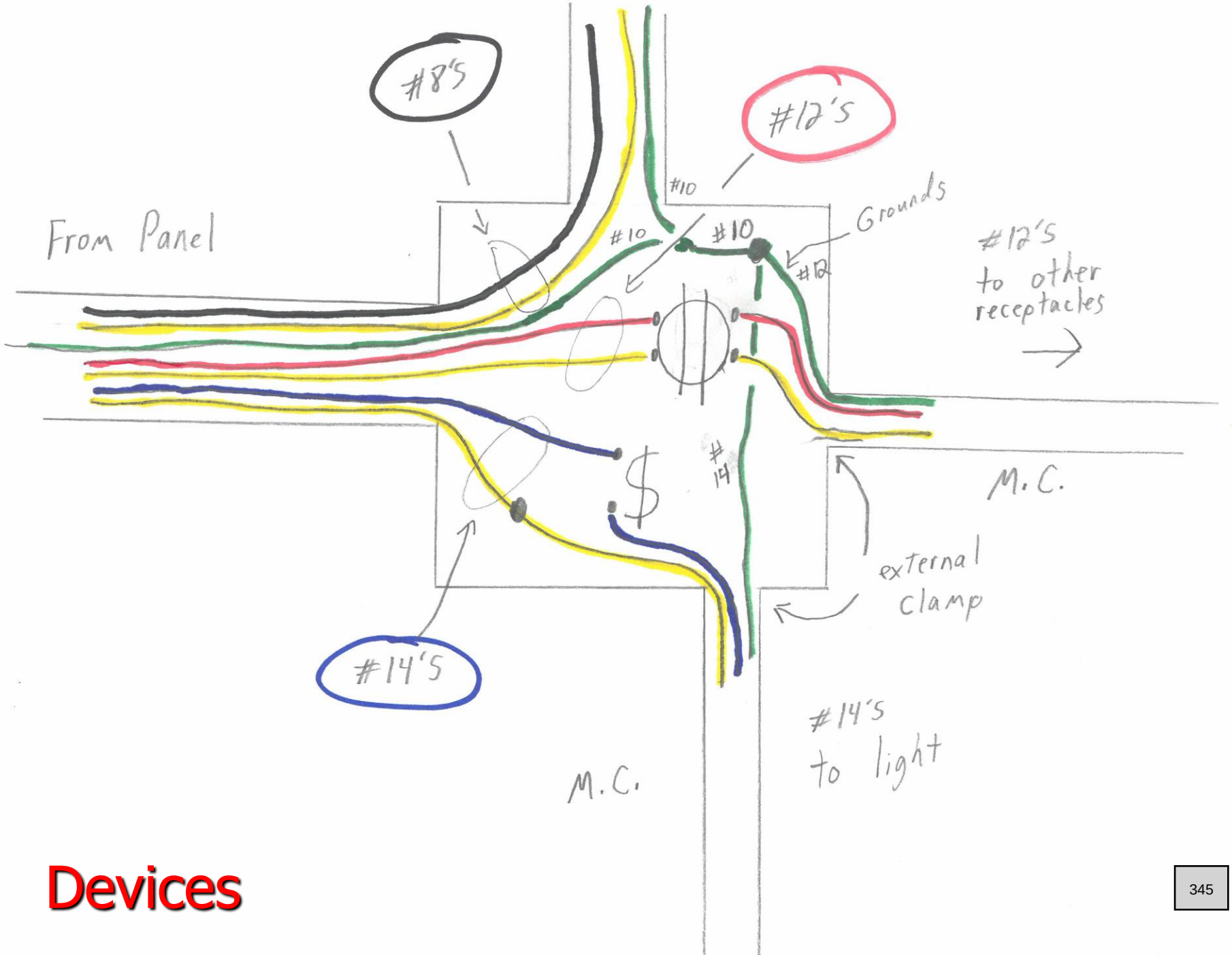
- 2 - #12's enter the box and 2 leave the box. This is not going straight through.
- Therefore you have 4 - #12 conductors
- Each #12 has a volume of 2.25 in. cubed
  - Therefore 4 x 2.25 = 9



#14 conductors (hots and neutrals)

Box Fill

- 2 - #14's enter the box and 2 leave the box. Since the neutral is spliced, this is not going straight through.
- You have 4 - #14 conductors
  - 4 x 2.00 = 8 inches cubed


#8's
#12's
#10
From Panel
#10
#10
Grounds
#12
#12's
to other
receptacles
#14
M.C.
external
clamp
#14's
M.C.
#14's
to light

Devices

Box Fill

- This takes care of your hots and neutrals.

Devices

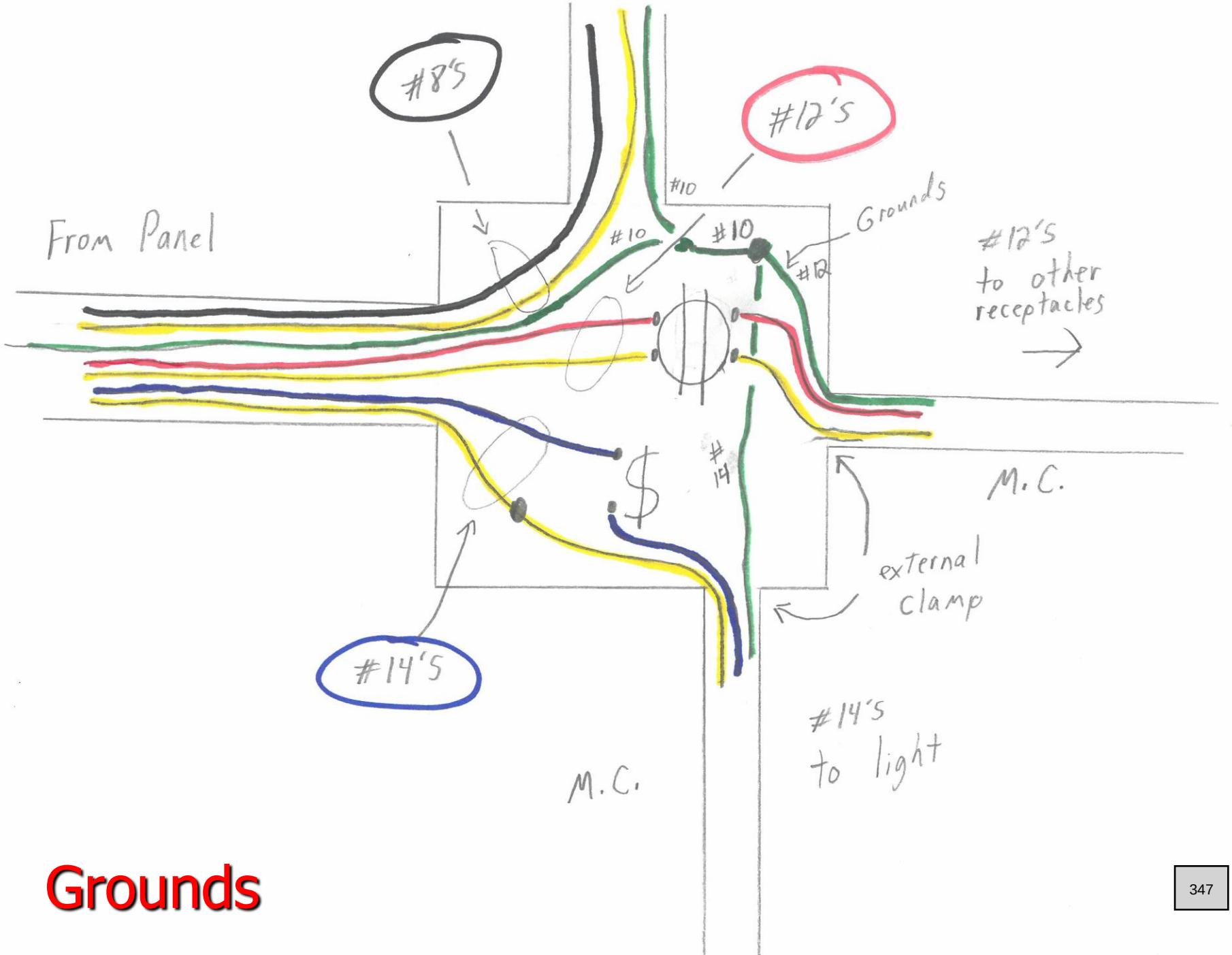
#12's land on the receptacle

For a device, you take double the allowance of the largest conductor landed on the devices

2 x 2.25 (#12) = 4.5

#14's land on the switch

2 x 2.00 (#14) = 4.0

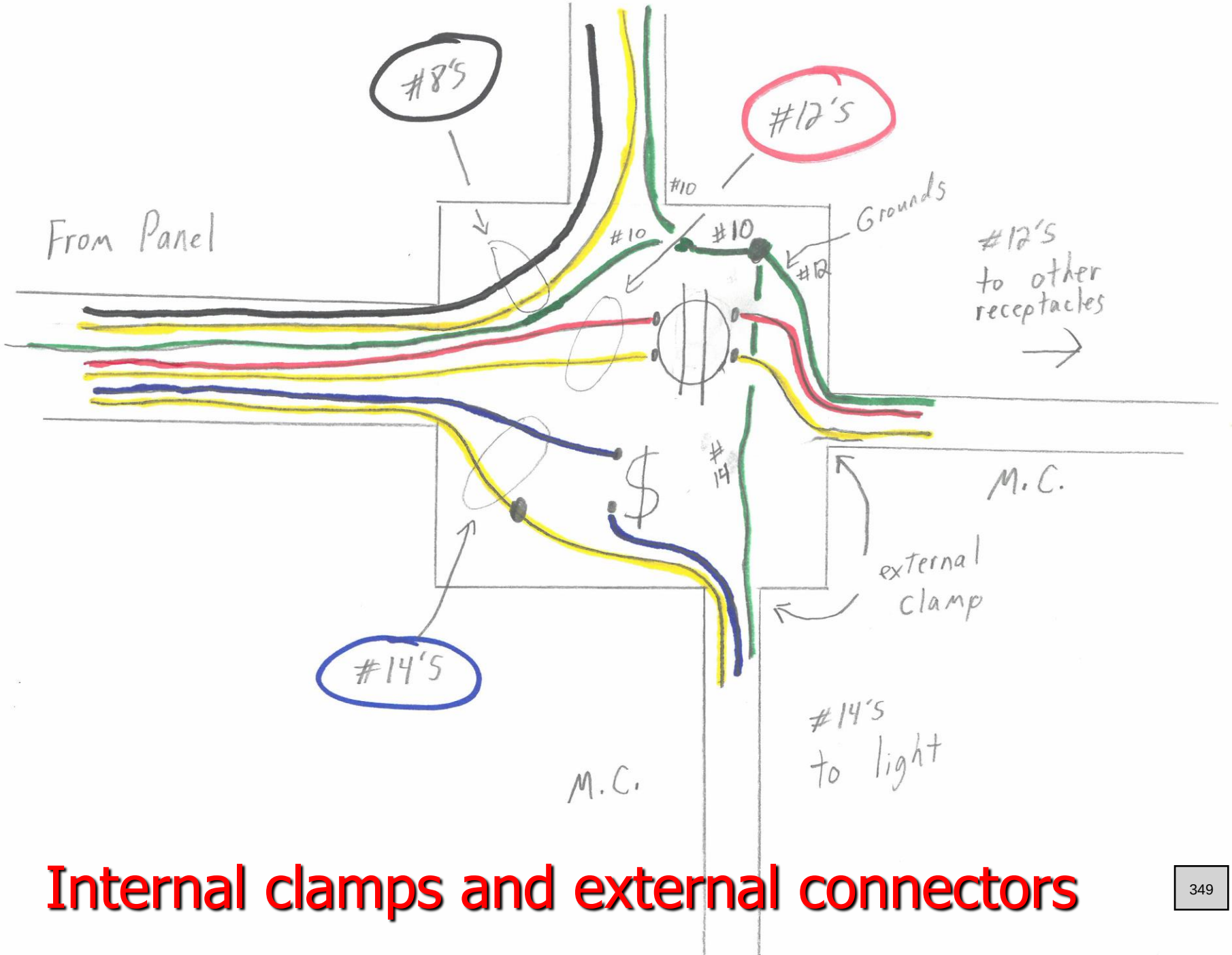

#8's
#12's
#10
From Panel
#10
#10
Grounds
#12
#12's
to other
receptacles
#14
M.C.
external
clamp
#14's
M.C.
#14's
to light

Grounds

Box Fill

- Grounds
  - You only need to take the largest size
  - There is 2 - #10's, 1 - #12 and 1 - #14

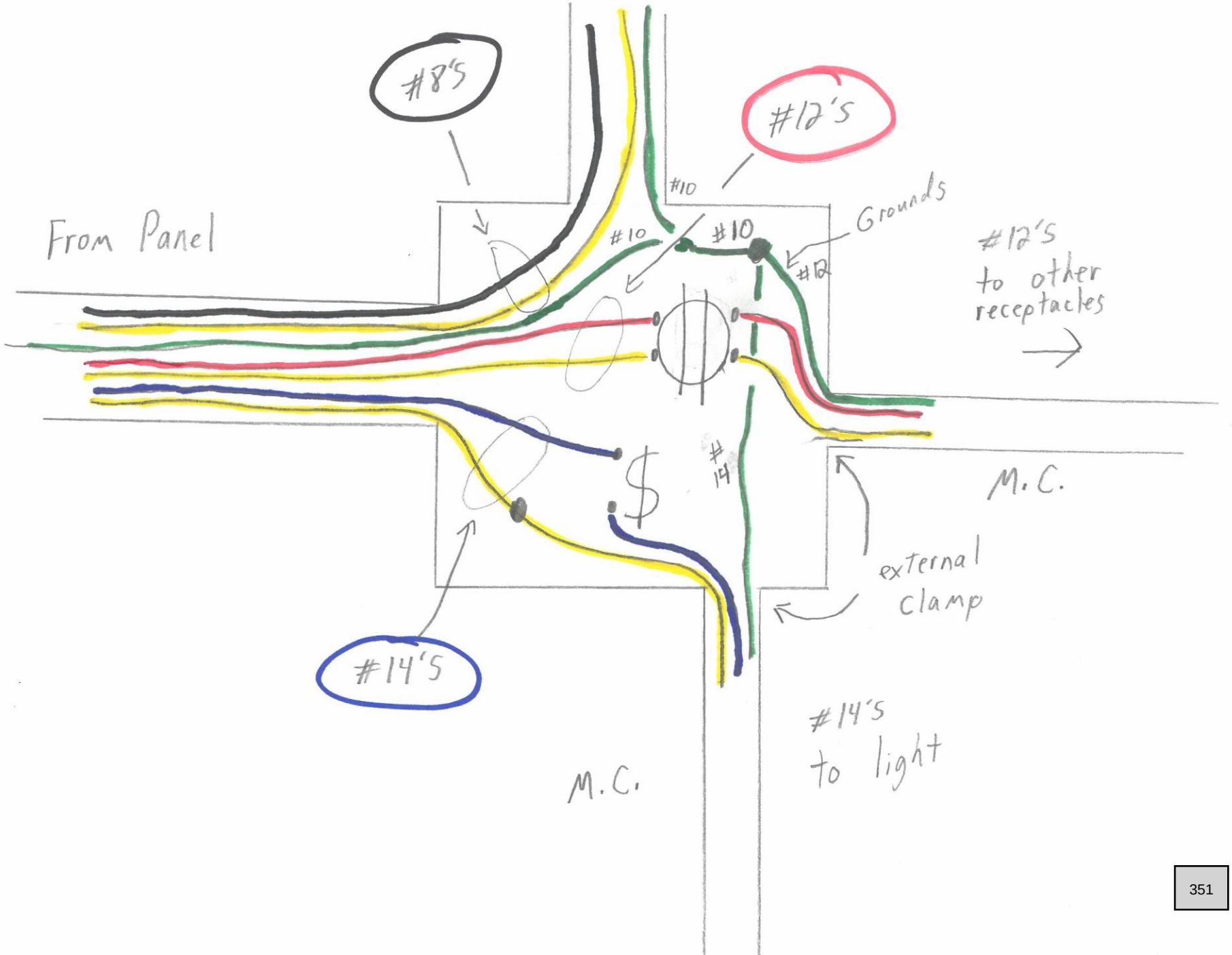
  1 x 2.5 (#10) = 2.5



Internal clamps and external connectors

Box Fill

- Clamps
- You have two external clamps
  - NO ALLOWANCE REQUIRED
- Had this been internal clamps you would have taken 1 x 3.00. No matter how many internal clamps you have, take 1 x the largest conductor in the box.


#8's
#12's
#10
From Panel
#10
#10
Grounds
#12
#12's
to other
receptacles
#14
M.C.
external
clamp
#14's
M.C.
#14's
to light

Box Fill

- Therefore

6 (# 8's passing through)

9 (#12's hots and neutrals on receptacle)

8 (#14's hots and neutrals on switch)

4.5 (receptacle - #12's on it)

4 (switch - #14's on it)

+ 2.5 (grounds – based on 1 - #10)

34

Box Fill

34 Cubic Inches are needed.

- You could legally have a 4 11/16 x 2 1/8 square box contain the conductors/devices.
- No 4 square is big enough – maxes at 30.3

Box fill

- What is the minimum size square box is needed for
- 4 - #14 phase conductors
- 3 - #12 phase conductors
- 2 - #10 phase conductors
- 2 - #10 equipment ground
- 2 - #12 equipment grounds
- 1 device attached to the #12
- 2 external clamps
- 2 internal clamps:

Box fill

- What is the minimum size square box is needed for
- 4 - #14 phase conductors = **4 x 2.00 = 8**
- 3 - #12 phase conductors = **3 x 2.25 = 6.75**
- 2 - #10 phase conductors = **2 x 2.50 = 5.00**
- 2 - #10 ground = **1 x 2.50 = 2.50 (only 1 needed)**
- 2 - #12 grounds = **0 (#10 ground accounted for)**
- 1 device = **2 x 2.25 = 4.50**
  - **(twice the largest conductor attached to device)**
- 2 external clamps = **0 = no allowance needed**
- 2 internal clamps = **1 x 2.50 = 2.50**

8.00 + 6.75 + 5.00 + 2.50 + 4.50 + 2.50 =**29.25**

Box fill

29.25 Cubic Inches

Go to box volume

make sure to look up correct box type (round, square, device, masonry)

4 11/16 x 1 ½" has a 29.5 allowance.

4 11/16 x 2 1/8" and 4 x 2 1/8" would be legal but would not be correct

- Pick **minimum** size needed.
- Do not pick largest box so that you are covered.

Box fill

- If box has #4 or larger, use 314.28
  - Refers to this article in 314.16
    - Straight Pulls
    - Angle or U Pulls

If conductors are pulled straight through a box, multiply the largest raceway by 8. The product will be the minimum length of the box to the opposite wall.

Box fill

Ex: A 3” conduit contains #10, #8 and #2 conductors. There is a pull box in the middle of a straight run which has the 3” conduit entering and leaving on opposite walls would require at LEAST a 24”x24” box (3” x 8) across.

Box fill

- A box will angle or U bends
- (anything not straight through)
  - Take the largest conduit on ONE side and multiply it by 6.
  - Add any additional conduits ON THE SAME SIDE to it.
  - This is the minimum dimension to the opposite wall of the box.
  - Technically must be done to all 4 sides.

Box fill

Ex: A pull box contains 1/0, #3's and #12's has:

1 - 2", 3 – 1" and 2 – ¾" conduit on the left side.

1 – 2", 3 – 1" on the bottom.

2 – 1" on the right.

Box fill

1 - 2″, 3 – 1″ and 2 – ¾″ conduit on the left side.
1 – 2″, 3 – 1″ on the bottom

2 – 1″ on the right.

- Left side:

1 – 2″ (largest size) = 2″ x 6 = 12″

12″ + 1″ + 1″ + 1″ + ¾″ + ¾″ = 16 ½″

Box fill

1 - 2”, 3 – 1” and 2 – ¾” conduit on the left side.
1 – 2”, 3 – 1” on the bottom
2 – 1” on the right.

- Bottom:

1 – 2” (largest size) = 2” x 6 = 12”
12” + 1” + 1” + 1” + = 15”

Box fill

1 - 2”, 3 – 1” and 2 – ¾” conduit on the left side.
1 – 2”, 3 – 1” on the bottom
2 – 1” on the right.

- Right side:

1 – 1” (largest size) = 1” x 6 = 6”
6” + 1”= 7”

Box fill

- From Left side – 16 ½” across
- From Bottom – 12” up
- From Right side – 7” across

- Smallest pull box would be 16 ½”.
  - If in field, would just round up.

File Attachments for Item:

EC-4 Conductor Types, Ampacities, Correction Factors (Independent Electrical Contractors)

EPE, ESI, RBO (4 hours)

Box and conduit fill – derating
9/17/09
5-8 PM

5 P.M.
Box Fill

By applying 310.14, you need to know how many conductors you can legally fit in a metal or plastic box. Devices and supports can also affect your calculation

6 P.M.
Sizing conduits

By using tables 4 and 5 in the NEC you can calculate the total area of the conductors you are running as well as the allowable space inside of different types and sizes of conduits

7 P.M.
Derating ampacities

310.15 (b)(2) lessens the ampacity allowed for conductors once you have put more than 4 conductors in a raceway. We will look at common derating factors and apply them to normal construction applications.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Kevin Collins (Contact Name)
Organization: IEC of Greater Cincinnati (Organization/Company)
Address: 586 Kings Run Drive (Include Room Number, Suite, etc.)
City: Cincinnati State: OH Zip: 45232
E-Mail: KCollins@iec-cincy.com
Telephone: 513-542-0400 Fax: —
Course Sponsor: IEC of Greater Cincinnati

COURSE INFORMATION:

Course Title: Conductor types, ampacities, correction Factors

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: Review article 310 of the NEC. We will discuss where different types of conductors are allowed and not allowed. We will also allowable ampacities as well as corrected ampacities based on ambient temperatures and number of conductors in a conduit.

Number of Instructional Contact Hours that can be obtained upon completion: 4

If Multi-Session, Number of Instructional Contact Hours Per Session: —

Program Applicable for the Following Participants:

Building Official ☐	Master Plans Examiner ☐	Building Inspector ☐	Fire Protection Inspector ☐	Mechanical Inspector ☐
	Plumbing Plans Exam. ☐			Plumbing Inspector ☐
	Electrical Plans Exam. ☒			Non-Res IU Inspector ☐
	Mechanical Plans Exam. ☐			

Res Building Official ☒ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☒
Location of ESI Course: IEC of Greater Cincinnati Date(s) of ESI Course(s): 10/19/22

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
Course Sponsor:	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:	Copy of quizzes or tests to be given	
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Sean Clark

901 Beechmeadow Ln. Cincinnati, Ohio 45238
(H)513/347-9054 (C)513/800-4450
sclark@ohiovalleyelectric.com

••••••••••••••••••••••••••••

A licensed electrician with over twenty years of experience in installing, maintaining, and repairing electrical wiring, equipment, and fixtures, ensuring that work is in accordance with relevant codes, fire alarm installations, electrical control systems, and high voltage terminations. A licensed electrician with three years teaching experience in first and second year electrical.

Summary of Qualifications

- More than twenty years experience.
- Three years experience in teaching first and second year electrical.
- Thorough knowledge of electrical systems including planning additions and modifications on secondary circuits. Controls and low voltage wiring
- Able to read commercial electrical blueprints and apply NEC through the full range of commercial and industrial maintenance and construction work.
- Can use appropriate tools and diagnostic equipment to repair, install, replace, and test electrical circuits, equipment and appliances.
- Excellent ability to diagnose and repair electrical controls, industrial motor control centers, and programmable logic controllers.
- Strong desire to study and comprehend new technology.
- In-depth ability to make mathematical computations.
- Considerable ability to explain instructions and guidelines to others effectively.
- Able to assign work to employees., prioritize the work of others and organize and coordinate the work of the unit. For subs and Primes.

Professional Experience

Ohio Valley Electrical Services 2011-Present

ABC Electrical Teacher 2010-2013

Beacon Electrical Contractors 2007-2011

Ohio Valley Electrical Services 1993-2007

Electrical Superintendant/Foreman/Instructor

- First and Second year electrical instructor
- Supervision of all electrical installations of as many as 50 electricians to assure that work was done safely, efficiently, properly and within time allowed.
- Trained multiple employees in all aspects of electrical work to be able to identify an employee's strengths and weaknesses to better utilize their skills. Traced out short circuits in wiring, using test meter.
- Coordinated and implemented electrical projects within a variety of environments including plants, hospitals, schools, retail stores, public facilities, waste water treatment plants industrial buildings;

projects include both new construction and underground electrical wiring as well as renovation within existing buildings. Parking Garages and Fed Ex Ground Facilities.

- Assemble, install, test, and maintain electrical or electronic wiring, equipment, appliances, apparatus, and fixtures, using hand tools and power tools.
- Connect wires to circuit breakers, transformers, or other components.
- Construct and fabricate parts, using hand tools and specifications.
- Diagnose malfunctioning systems, apparatus, and components, using test equipment and hand tools, to locate the cause of a breakdown and correct the problem.
- Inspect electrical systems, equipment, and components to identify hazards, defects, and the need for adjustment or repair, and to ensure compliance with codes.
- Plan layout and installation of electrical wiring, equipment and fixtures, based on job specifications and local codes.
- Test electrical systems and continuity of circuits in electrical wiring, equipment, and fixtures, using testing devices such as ohmmeters, voltmeters, and oscilloscopes, to ensure compatibility and safety of system.
- Perform business management duties such as maintaining records and files, preparing reports and ordering supplies and equipment.

Education & Certifications

Master Electrician License-State of Kentucky

Journeyman Electrician's License-Hamilton, Ohio

Fire Alarm License-State of Ohio

Certified in high voltage terminations and splices

Lift, Lull, Bobcat, and Boom/scissors lift licenses

OSHA-30 card

Certified in first aid and CPR training

Certified NCCER Core Curricula Instructor

Certified NCCER Electrical Instructor

Completed 4 year apprenticeship program

1 Year Pre-apprentice school (ABC)

High School Diploma (1991)

ARCH FLASH SAFETY TRAINING

PROJECTS-SUPERVISED

$4.5mil.-MASON HIGH SCHOOL ADDITION

$250.000-3CDC-5TH RACE PARKING GARAGE

$250.000-AVONEDALE APT. COMPLEX

$100.000-MAHOGANYS AT THE BANK-

1.2mil. -PATHEON CHEMICALS

$450.000- FED EX GROUND ADDITION

$250.000-LIBERTY WAY PROJECT

$500.000-GE AT THE BANKS

$100.000 - SYCAMORE SCHOOLS/POWER/CONTROL-

$50.000 - NKU RETROFIT

$250.000- UC POWER PLANT ADDITION

$75.000 - 580BLD/ CHEMED, RETROFIT

$4.0mil - DHL- CONVEYERS/SHELL

$90.000- DOUBLE TREE AIRPORT

$2.5mil- TWIN LAKES OF MONTGOMERY

$45.000- STEINMART ANDERSON

And many small T&M jobs.

All on time and under budget

Ampacities
Article 310.15 & 16

Ampacities

- 310.15(B)(16)

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

	Temperature Rating of Conductor [See Table 310.104(A).]						
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
Size AWG or kcmil	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Size AWG or kcmil
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
**Refer to 240.4(D) for conductor overcurrent protection limitations.

Ampacities

- How many amps is Al THW-2 #4 good for?
  - Go to right half of the chart (Aluminum conductors)
  - Find THW – 2 in the categories at the top
    - Use the 90 degree C column
  - Find #4 on the far right side
  - Find where that column and the #4 row cross.

  - 75 amps

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.104(A).]						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
**Refer to 240.4(D) for conductor overcurrent protection limitations.

Ampacities

- Copper vs. Aluminum
- Use wire insulations
- DON'T WORRY ABOUT LUG RATING

How many amps are each of the following good for:

- 3/0 RHW AL
- #3 UF Cu
- 4/0 RHW-2 Cu

Ampacities

- Copper vs. Aluminum
- Use wire insulations
- DON'T WORRY ABOUT LUG RATING

How many amps are each of the following good for

- 3/0 RHW AL – **155**
- #3 UF Cu - **85**
- 4/0 RHW-2 Cu - **260**

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.104(A).]						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
**Refer to 240.4(D) for conductor overcurrent protection limitations.

Ambient temperature – 310.15(B)(2)(a)

Table 310.15(B)(2)(a) Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor			Ambient Temperature (°F)
	60°C	75°C	90°C	
10 or less	1.29	1.20	1.15	50 or less
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.11	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	132–140
61–65	—	0.47	0.65	141–149
66–70	—	0.33	0.58	150–158
71–75	—	—	0.50	159–167
76–80	—	—	0.41	168–176
81–85	—	—	0.29	177–185

Ambient temperature

- Outside temperature, this is different than temperature rating of wire
- Celsius on left – Fahrenheit on right
  - Make sure to answer in correct temperature
- Ex: Use the same example we had before
- Al THW-2 #4 in 77 degree C ambient temperature
  - Take your initial amps that you found (75 amps)
  - Apply the ambient temperature factor (.41)
    - It will be in the same column as the initial amp finding
    - Find the ambient temperature on the edge of the chart
    - Could be left side (C) or right side (F)
  - Multiply the amps by the ambient temperature correction factor
- 75 x .41 = 30.75 amps

Ambient temperature

- Determine the ampere rating for each of the following conductors:

- 3/0 RHW Al in 42 C ambient temperature
- #3 UF Cu in 90 F ambient temperature
- 4/0 RHW-2 Cu in 75 F ambient temperature

Ambient temperature

Determine the ampere rating for each of the following conductors

- 3/0 RHW Al in 42 C ambient temperature
  - **127.1 amps – correction factor of .82**
- #3 UF Cu in 90 F ambient temperature
  - **77.35 amps – correction factor of .91**
- 4/0 RHW-2 Cu in 75 F ambient temperature
  - **270.4 amps – correction factor of 1.04**

You can exceed the rating of 310.15(B)(16)

Adjustment factors - derating

- 310.15(B)(3)(a)

Table 310.15(B)(3)(a) Adjustment Factors for More Than Three Current-Carrying Conductors in a Raceway or Cable

Number of Conductors[1]	Percent of Values in Table 310.15(B)(16) through Table 310.15(B)(19) as Adjusted for Ambient Temperature if Necessary
4–6	80
7–9	70
10–20	50
21–30	45
31–40	40
41 and above	35

[1]Number of conductors is the total number of conductors in the raceway or cable adjusted in accordance with 310.15(B)(5) and (6).

Adjustment factors - derating

- Based on number of **current carrying** conductors
- HAS NOTHING TO DO WITH TYPE OR SIZE OF CONDUIT
  - 4 - #18 conductors in 6” Rigid would still be derated

- Ex: Use the same wire as before.
- What is the ampacity of 11 - Al THW-2 #4
- Take initial ampacity (75 amps)
- Use 310.15 (B)(3)(c) to apply the correction factor
- 10 – 20 has a factor of 50% (.5)
- 75 x .5 = 37.5 = **38 Amps**

Adjustment factors - derating

Determine the ampere rating for each of the following conductors:

- 5 - 3/0 RHW Al
- 21 - #3 UF Cu
- 8 - 4/0 RHW-2 Cu

Adjustment factors - derating

- Determine the ampere rating for each of the following conductors

- 5 - 3/0 RHW Al
  - **124 amps – derate at 80%**

- 21 - #3 UF Cu
  - **38.25 amps – derate at 45%**
    - Have to round down to 38 amps – decimal below .5

- 8 - 4/0 RHW-2 Cu
  - **182 amps – derate at 70%**

Combining factors for derating

- If taking into account ambient temperature and correction factor (derating) you must apply BOTH not the greatest of the two.

- Ex: 11 - Al THW-2 #4 in 77 degree C ambient temperature
  - 75 amps (off 310.15(B)(16))
  - .41 (ambient temp)
  - .5 (derating chart, 310.15 (B)(3)(a)
- 75 x .41 x .5 = 15.375 = 15 amps
- Each conductor is only good for 15 amps

Combining factors for derating

- Determine the ampere rating for each of the following conductors:

- 5 - 3/0 RHW Al in 42 C ambient temperature
- 21 - #3 UF Cu in 90 F ambient temperature
- 8 - 4/0 RHW-2 Cu in 75 F ambient temperature

Combining factors

- Determine the ampere rating for each of the following conductors

- 5 - 3/0 RHW Al in 42 C ambient temperature
  - 155 x .82 x .8 = 101.68 = **102 amps**
- 21 - #3 UF Cu in 90 F ambient temperature
  - 85 x .91 x .45 = 34.8075 = **35 amps**
- 8 - 4/0 RHW-2 Cu in 75 F ambient temperature
  - 260 x 1.04 x .7 = 189.28 = **189 amps**

Dwelling Service Chart 310.15(B)(7)

- 83% Rule
  - Only for dwelling purposes
  - 100 amps through 400 amps
  - Must feed entire load
  - Single phase or single phase from a 3 phase system

Rephrased – Same Values

- 83% Rule
- Take rating of service and multiply by .83 (83%)
- Ex. 200 amp service
  - 200 x .83 = 166

- Refer to 310.15(B)(16) – Main Ampacity Chart
- Find conductors rated for at least 166 amps
  - Unless noted, use 75 degree column and copper

Dwelling Service Chart 310.15(B)(7) – page 800

Table 310.15(B)(7) Conductor Types and Sizes for 120/240-Volt, 3-Wire, Single-Phase Dwelling Services and Feeders. Conductor Types RHH, RHW, RHW-2, THHN, THHW, THW, THW-2, THWN, THWN-2, XHHW, XHHW-2, SE, USE, USE-2

Service or Feeder Rating (Amperes)	Conductor (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum
100	4	2
110	3	1
125	2	1/0
150	1	2/0
175	1/0	3/0
200	2/0	4/0
225	3/0	250
250	4/0	300
300	250	350
350	350	500
400	400	600

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.104(A).]						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
**Refer to 240.4(D) for conductor overcurrent protection limitations.

Dwelling Service

What size copper conductors are needed for a 150 amp residential single phase service?

Dwelling Service

What size copper conductors are needed for a 150 amp residential single phase service?

150 x .83 = 124.5 amps

#1 is good for 130 amps

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.104(A).]						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
**Refer to 240.4(D) for conductor overcurrent protection limitations.

Table 310.15(B)(7) Conductor Types and Sizes for 120/240-Volt, 3-Wire, Single-Phase Dwelling Services and Feeders. Conductor Types RHH, RHW, RHW-2, THHN, THHW, THW, THW-2, THWN, THWN-2, XHHW, XHHW-2, SE, USE, USE-2

Service or Feeder Rating (Amperes)	Conductor (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum
100	4	2
110	3	1
125	2	1/0
150	1	2/0
175	1/0	3/0
200	2/0	4/0
225	3/0	250
250	4/0	300
300	250	350
350	350	500
400	400	600

Ampacities

- 310.15(B)(16) vs. 310.15 (B)(7)
  - 310.15 (B)(7) is for 120/240, 3 wire, single phase dwelling services and feeders
    - Ex. Houses, apartments
    - Feeders is a bit deceptive
  - Notice the difference in ampacities!
    - 200 amp Dwelling feeder is permitted to be 4/0 AL
    - On 310.16 if you needed 200 amps on Al wire, you would need 250 kcmil
- Only refer to 310.15 (B)(7) when all stipulations are given

Conductor Properties

- 310.4 (A)
  - Gives trade name and type letter
  - Maximum operating temperature
    - Conductors may have different operating temperatures in different environments
      - See type ZW
  - Insulation
  - Outer covering

Conductor Properties

- 310.4 (A)
- Which conductor is good for switchboard and switchgear wiring only?

- A. ZW
- B. SA
- C. MTW
- D. TBS

400

Conductor Properties

- 310.4 (A)
- Which conductor is good for switchboard and switchgear wiring only?

- A. ZW
- B. SA
- C. MTW
- **D. TBS**

File Attachments for Item:

EC-5 Dwelling Circuit Requirements (Independent Electrical Contractors)

EPE, ESI, RBO (4 hours)

Dwelling requirements

Required receptacles

- 6 foot rule – no point along the wall may be more than 6 feet from a receptacle
- 2 foot walls – the minimum size wall that is required to have receptacles
- Kitchen countertops – no point along these walls can be more than 2 feet away from a receptacle
- Appliance receptacles – at least one within 6 feet.
- Bathrooms – one per bathroom required
- Outside – receptacles are required at the front and back of the house
- Hallways – 10 foot or more require receptacles
- Garages with power – at least one required

Services

- Minimum size
- Location

Lighting

- Switched outlets required

Clearances

- Underground burial depths
- Overhead conductor minimum heights

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Kevin Collins (Contact Name)
Organization: IEC of Greater Cincinnati (Organization/Company)
Address: 586 Kings Run Drive (Include Room Number, Suite, etc.)
City: Cincinnati State: OH Zip: 45232
E-Mail: KCollins@iec-cincy.com
Telephone: 513-542-0400 Fax: —
Course Sponsor: IEC of Greater Cincinnati

COURSE INFORMATION:

Course Title: Dwelling Circuit Requirements

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: Review article 210 of the NEC. We will discuss receptacle & switch location requirements in a dwelling as well as required circuitry in a dwelling

Number of Instructional Contact Hours that can be obtained upon completion: 4

If Multi-Session, Number of Instructional Contact Hours Per Session: —

Program Applicable for the Following Participants:

Building Official ☐ Master Plans Examiner ☐ Plumbing Plans Exam. ☐ Electrical Plans Exam. ☒ Mechanical Plans Exam. ☐ Building Inspector ☐ Fire Protection Inspector ☐ Mechanical Inspector ☐ Plumbing Inspector ☐ Non-Res IU Inspector ☐

Res Building Official ☒ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☒
Location of ESI Course: IEC of Greater Cincinnati Date(s) of ESI Course(s): 10/12/22

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
Course Sponsor:	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:	Copy of quizzes or tests to be given	
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Sean Clark

901 Beechmeadow Ln. Cincinnati, Ohio 45238
(H)513/347-9054 (C)513/800-4450
sclark@ohiovalleyelectric.com

••••••••••••••••••••••••••••

A licensed electrician with over twenty years of experience in installing, maintaining, and repairing electrical wiring, equipment, and fixtures, ensuring that work is in accordance with relevant codes, fire alarm installations, electrical control systems, and high voltage terminations. A licensed electrician with three years teaching experience in first and second year electrical.

Summary of Qualifications

- More than twenty years experience.
- Three years experience in teaching first and second year electrical.
- Thorough knowledge of electrical systems including planning additions and modifications on secondary circuits. Controls and low voltage wiring
- Able to read commercial electrical blueprints and apply NEC through the full range of commercial and industrial maintenance and construction work.
- Can use appropriate tools and diagnostic equipment to repair, install, replace, and test electrical circuits, equipment and appliances.
- Excellent ability to diagnose and repair electrical controls, industrial motor control centers, and programmable logic controllers.
- Strong desire to study and comprehend new technology.
- In-depth ability to make mathematical computations.
- Considerable ability to explain instructions and guidelines to others effectively.
- Able to assign work to employees., prioritize the work of others and organize and coordinate the work of the unit. For subs and Primes.

Professional Experience

Ohio Valley Electrical Services 2011-Present

ABC Electrical Teacher 2010-2013

Beacon Electrical Contractors 2007-2011

Ohio Valley Electrical Services 1993-2007

Electrical Superintendant/Foreman/Instructor

- First and Second year electrical instructor
- Supervision of all electrical installations of as many as 50 electricians to assure that work was done safely, efficiently, properly and within time allowed.
- Trained multiple employees in all aspects of electrical work to be able to identify an employee's strengths and weaknesses to better utilize their skills. Traced out short circuits in wiring, using test meter.
- Coordinated and implemented electrical projects within a variety of environments including plants, hospitals, schools, retail stores, public facilities, waste water treatment plants industrial buildings;

projects include both new construction and underground electrical wiring as well as renovation within existing buildings. Parking Garages and Fed Ex Ground Facilities.

- Assemble, install, test, and maintain electrical or electronic wiring, equipment, appliances, apparatus, and fixtures, using hand tools and power tools.
- Connect wires to circuit breakers, transformers, or other components.
- Construct and fabricate parts, using hand tools and specifications.
- Diagnose malfunctioning systems, apparatus, and components, using test equipment and hand tools, to locate the cause of a breakdown and correct the problem.
- Inspect electrical systems, equipment, and components to identify hazards, defects, and the need for adjustment or repair, and to ensure compliance with codes.
- Plan layout and installation of electrical wiring, equipment and fixtures, based on job specifications and local codes.
- Test electrical systems and continuity of circuits in electrical wiring, equipment, and fixtures, using testing devices such as ohmmeters, voltmeters, and oscilloscopes, to ensure compatibility and safety of system.
- Perform business management duties such as maintaining records and files, preparing reports and ordering supplies and equipment.

Education & Certifications

Master Electrician License-State of Kentucky

Journeyman Electrician's License-Hamilton, Ohio

Fire Alarm License-State of Ohio

Certified in high voltage terminations and splices

Lift, Lull, Bobcat, and Boom/scissors lift licenses

OSHA-30 card

Certified in first aid and CPR training

Certified NCCER Core Curricula Instructor

Certified NCCER Electrical Instructor

Completed 4 year apprenticeship program

1 Year Pre-apprentice school (ABC)

High School Diploma (1991)

ARCH FLASH SAFETY TRAINING

PROJECTS-SUPERVISED

$4.5mil.-MASON HIGH SCHOOL ADDITION

$250.000-3CDC-5TH RACE PARKING GARAGE

$250.000-AVONEDALE APT. COMPLEX

$100.000-MAHOGANYS AT THE BANK-

1.2mil. -PATHEON CHEMICALS

$450.000- FED EX GROUND ADDITION

$250.000-LIBERTY WAY PROJECT

$500.000-GE AT THE BANKS

$100.000 - SYCAMORE SCHOOLS/POWER/CONTROL-

$50.000 - NKU RETROFIT

$250.000- UC POWER PLANT ADDITION

$75.000 - 580BLD/ CHEMED, RETROFIT

$4.0mil - DHL- CONVEYERS/SHELL

$90.000- DOUBLE TREE AIRPORT

$2.5mil- TWIN LAKES OF MONTGOMERY

$45.000- STEINMART ANDERSON

And many small T&M jobs.

All on time and under budget

Required receptacles

- Kitchens (wall space), family rooms, dining rooms, parlor, bedroom, recreation room, etc.
  - 6 foot rule
  - 2 foot or wider wall sections
    - sections broken by doors, fireplaces, etc
  - Fixed door panels apply
  - Railings apply
    - Floor receptacles - less than 18" off the wall
    - Wall receptacles – less than 5 ½' above the floor

210.52(A)(2) WALL SPACE

(2) Wall Space. As used in this section, a wall space shall include the following:

(1) Any space 600 mm (2 ft) or more in width (including space measured around corners) and unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets that do not have countertops or similar work surfaces

(2) The space occupied by fixed panels in walls, excluding sliding panels

(3) The space afforded by fixed room dividers, such as free-standing bar-type counters or railings

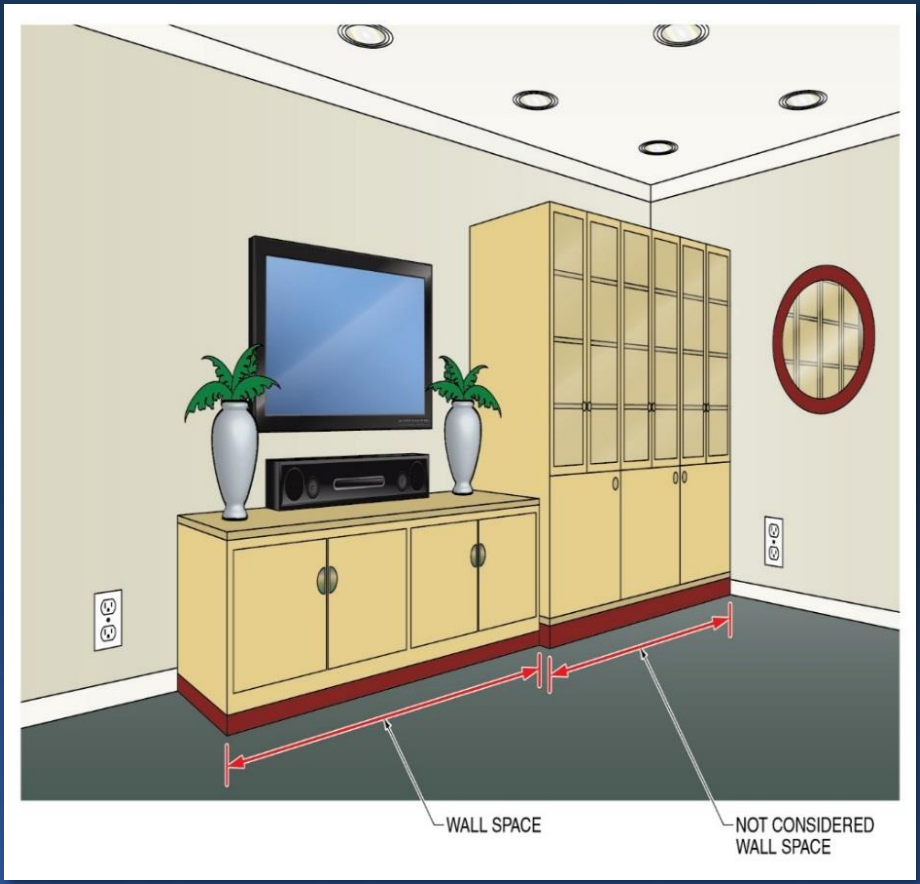
210.52(A)(2)(1) RECEPTACLE WALL SPACE

Changes have been made to clarify that countertops must be included when calculating wall space.

Kitchen type cabinets, bar area countertops, and home office counters are all considered wall space.

Key term is “fixed cabinets”.

At rough-in inspection, inspector should verify blueprints to see where cabinets are located to clarify areas that are not considered wall space.




411

Required receptacles

- Do not count as part of required receptacles
  - Part of a luminaire or appliance
  - Controlled by a wall switch
    - Unless half switched
  - In cabinets or cupboards

Required receptacles

- Kitchens countertops
  - 2′ rule
    - Spaces are broken by sinks, ranges, etc.
    - Does not apply if sink is:
      - Straight sink is more than 12″ off back wall
      - Corner sink is more than 18″ off back wall
  - Any space wider than 12″
  - Must be 20″ or less above countertop

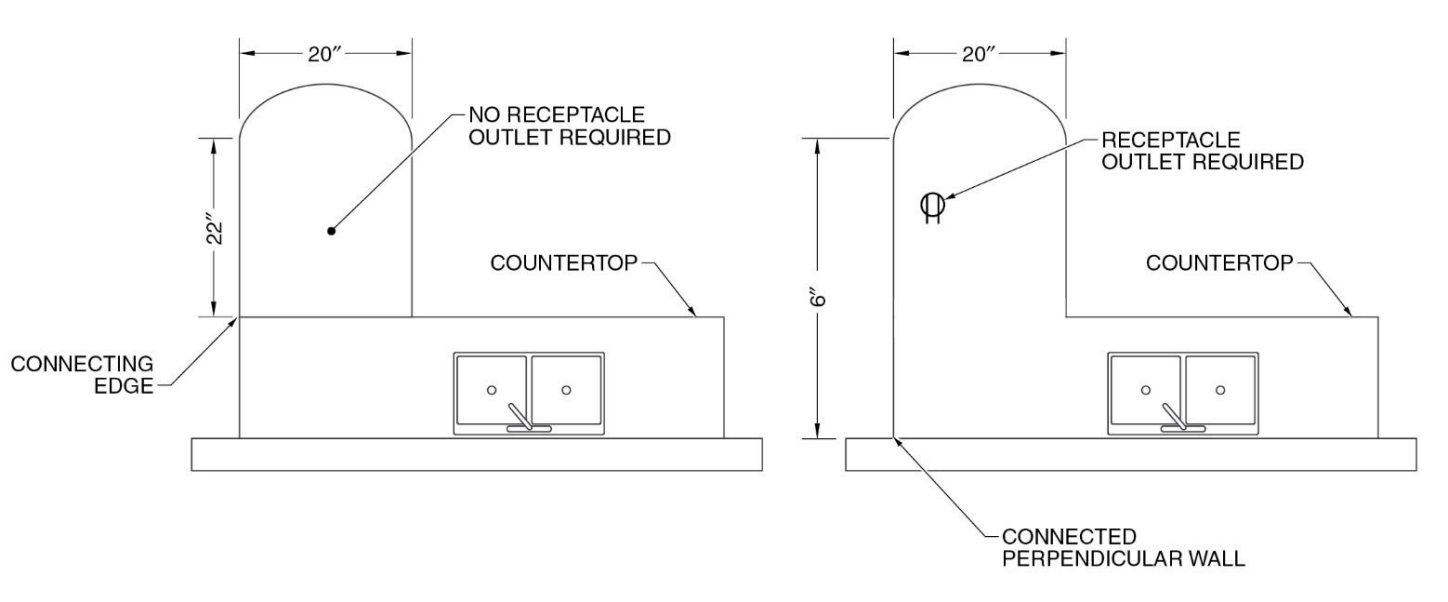
Required receptacles

- Islands
  - At least one if greater than 24" and 12"
  - Can count as two separate spaces is broken by sink, range, etc.
    - Not considered broken if more than 12" of counter behind.
- Peninsula
  - At least one if greater than 24" and 12"
    - Measured from wall
  - Same rules as islands

210.52(C)(3) PENINSULAR COUNTERTOP SPACES

(3) Peninsular Countertop Spaces. At least one receptacle outlet shall be installed at each peninsular countertop long dimension space with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater. A peninsular countertop is measured from the connected perpendicular wall.

210.52(C)(3) PENINSULAR COUNTERTOP SPACES



2014 NEC
Peninsular countertop long dimension is measured from the “connecting edge”

2017 NEC
Peninsular countertop long dimension is measured from the “connected perpendicular wall”

Required receptacles

- Kitchens
  - For physically impaired or flat counter (no backsplash)
    - Can be located below counter if less than 12”
      - Doesn’t apply if counter extends 6 or more inches over base
  - Kitchen counter receptacles can not face up
    - Not permitted anywhere

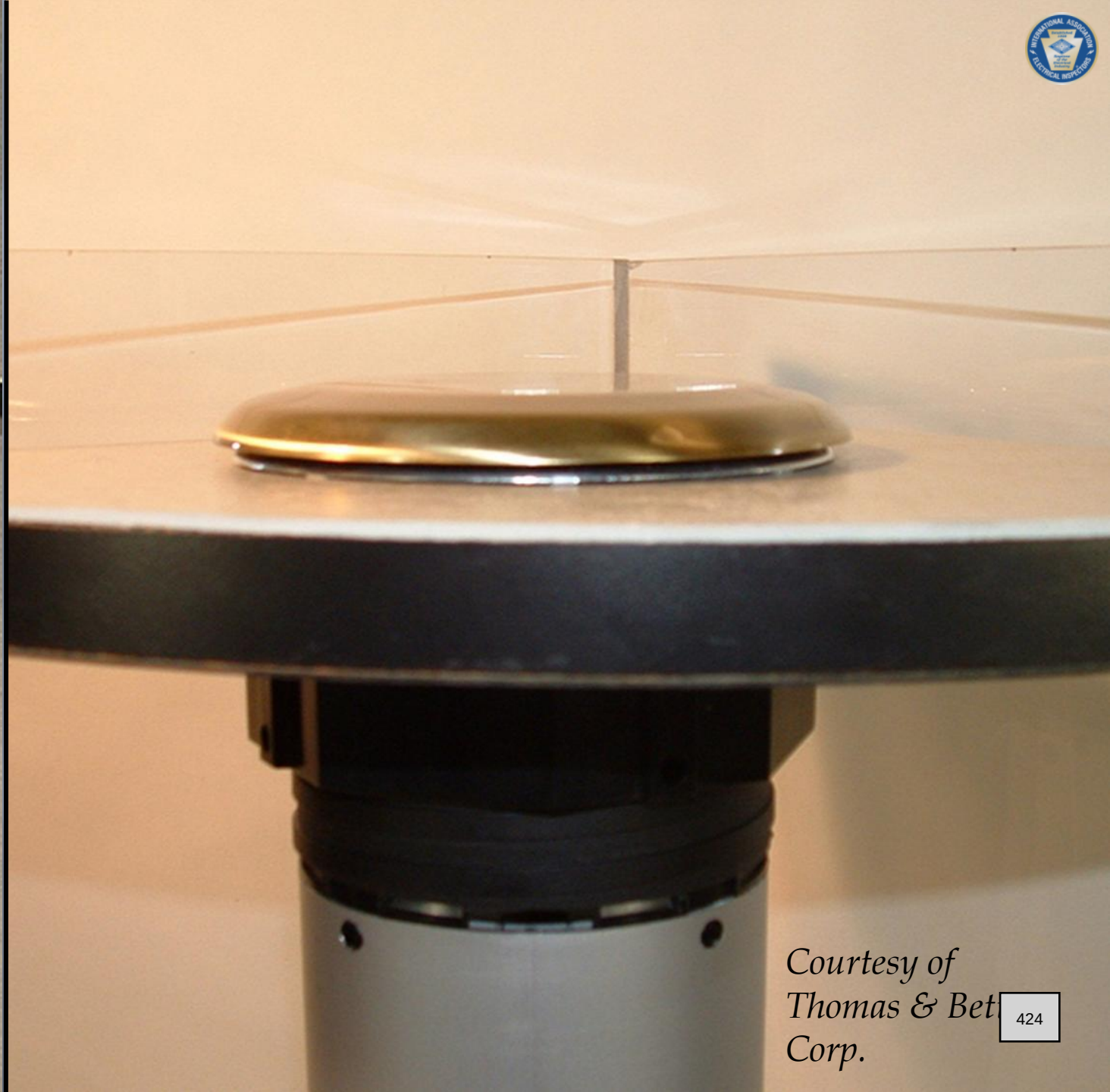
Required receptacles

- Appliance receptacles within 6’ of appliance
  - Laundry equipment
  - Refrigerator
- At least one receptacle in laundry
- Bathrooms
  - At least one – within 3’ of outer edge of each basin
  - Can be located not less than 12” below counter.
  - Listed receptacles may be used (pop up)

210.52(C)(5) and 210.52(D)

- Dwelling Unit Receptacle Outlet Locations:
  - Listed receptacle outlet assemblies are now permitted to be installed on or in kitchen and bathroom countertops to serve as the required countertop receptacles
  - Receptacle outlets must be located on, or above the countertop
  - Applies to countertops in bathrooms, kitchens, pantries, breakfast rooms, dining rooms, and similar areas of dwelling units
  - Receptacles shall not be installed in a face-up position in countertops or similar work surfaces *[406.5(E)]*

Courtesy of
Thomas & Betts Corp.



Courtesy of Thomas & Bet Corp.

Required receptacles

- Outdoors
  - One in front and back
    - Not more than 6 1/2′ above grade
    - All covers in use covers
    - Extra Duty
      - Clear “bubble” covers no longer allowed
- Balconies, Decks, Porches
  - One required if
    - Accessible from inside the dwelling
    - Any size, 20 square foot reference removed in 2011
  - If required, it must be
    - Accessible from the balcony
    - Less than 6 ½′ above surface

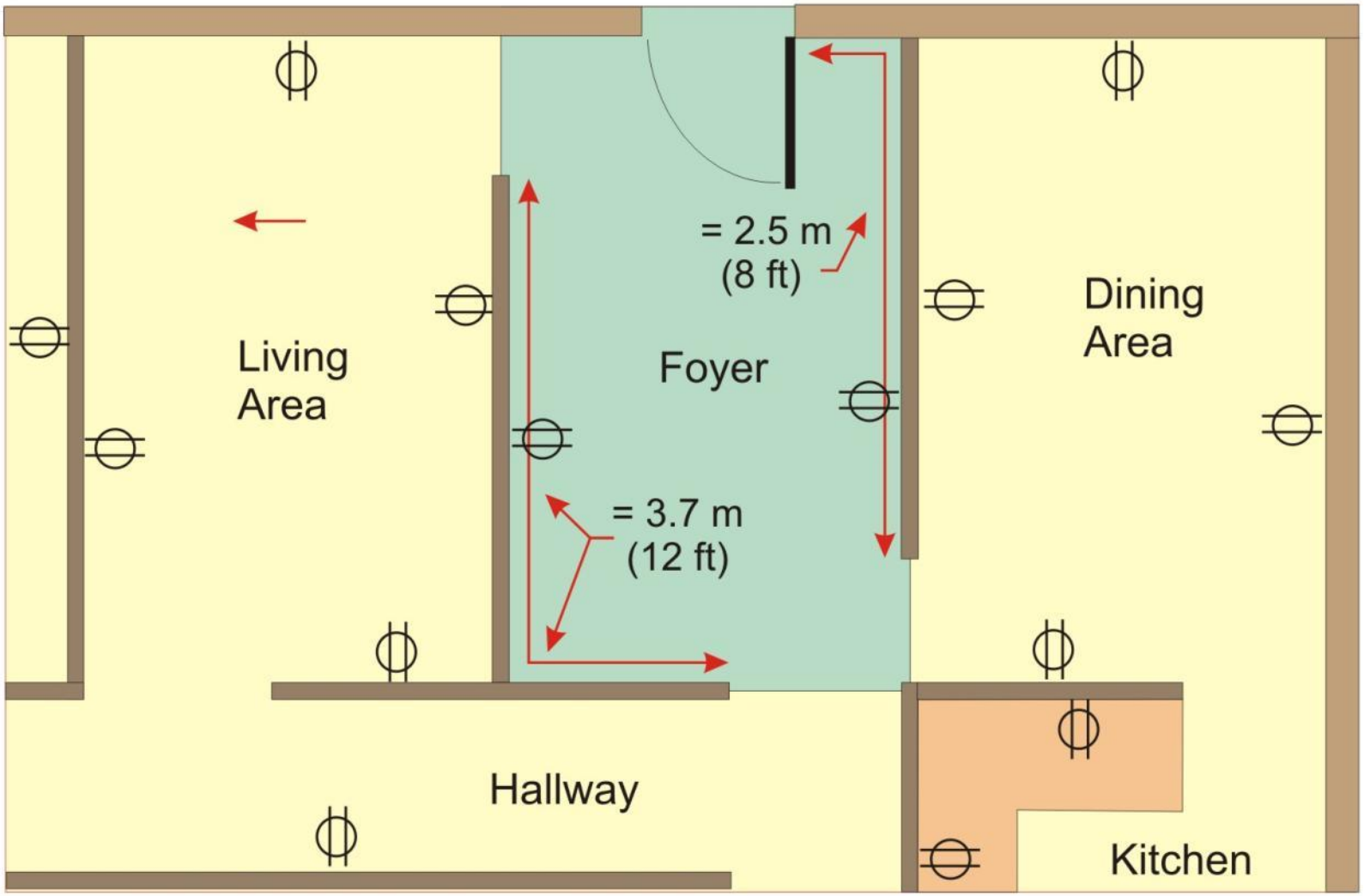
Required receptacles

- HVAC equipment
  - Within 25′ of HVAC or refrigeration equipment
- Receptacles can perform double duty
- Receptacles must be readily accessible from grade level

Required receptacles

- Hallways
  - Need only one if hallway is 10’ or longer
  - Passing through a door constitutes new area
- Foyers
  - Need at least one in each wall space 3 feet or wider
    - Does not fall under the 6 foot rule
  - Applies if foyer is 60 or more square feet

210.52(I) Foyers



Foyers that are not part of a hallway having an area that is greater than 5.6 m^2 (60 ft^2) are required to have a receptacle(s) located in each wall space 900 mm (3 ft) or more in width

Required receptacles

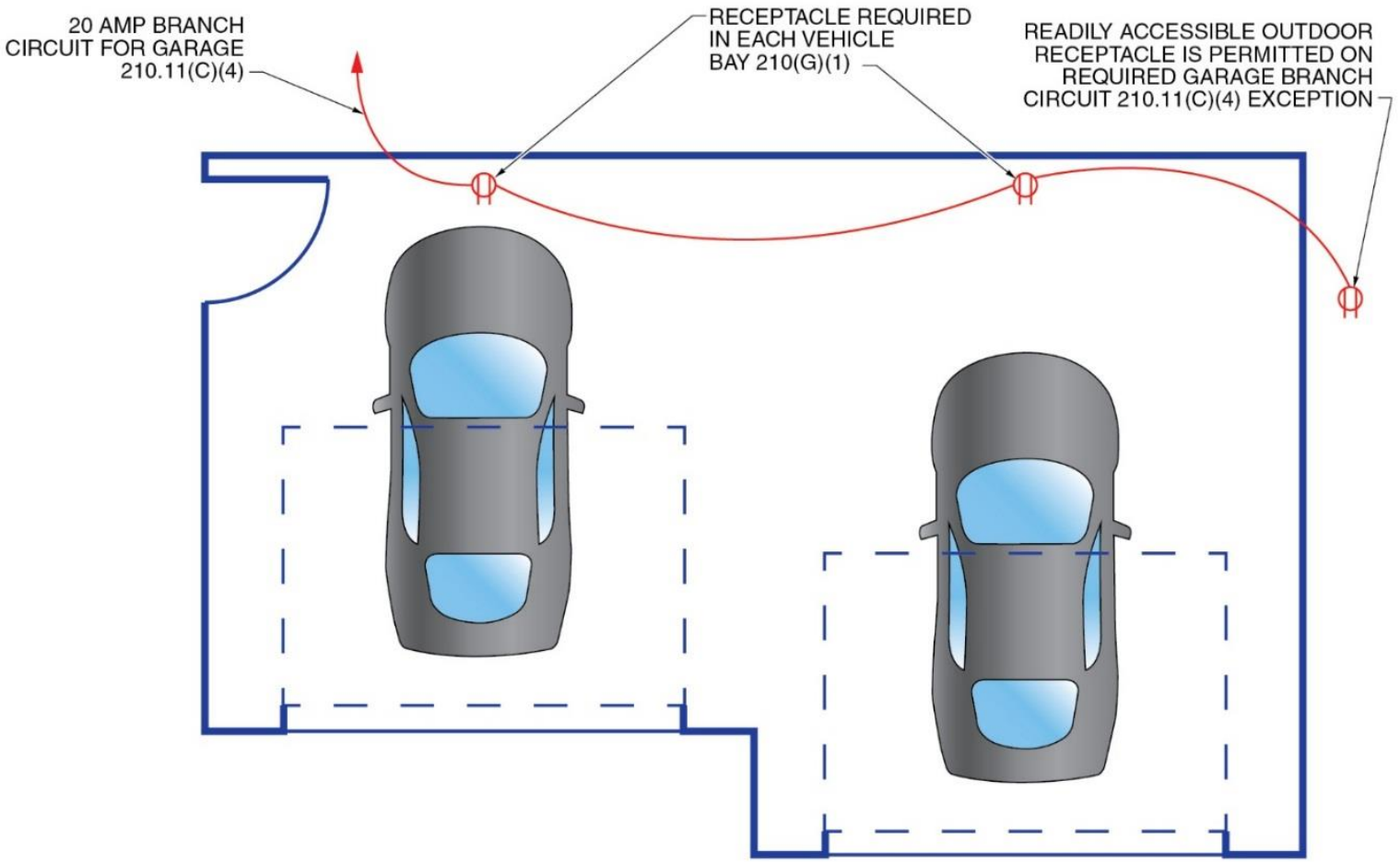
- Garage
  - Receptacles for specific equipment do not count towards required receptacles.
    - Central Vac , Garage door
  - Circuit must be dedicated in garage – 210.52 (G)(1)
    - Same rule applies for detached garage – if it has power
    - Separate circuit for attached and detached?
  - One receptacle for each car space - 210.52 (G)(1)
  - Vehicle charging circuit must be dedicated – 210.17
    - Only if installed.

210.52(G)(1) VEHICLE BAY OUTLETS

(G) Basements, Garages, and Accessory Buildings. For one- and two-family dwellings, at least one receptacle outlet shall be installed in the areas specified in 210.52(G) (1) through (3). These receptacles required for specific equipment.

(1) Garages. In each attached garage and in each detached garage with electric power, at least one receptacle outlet shall be installed in each vehicle bay and not more than 1.7 m (5-1/2 ft) above the floor.

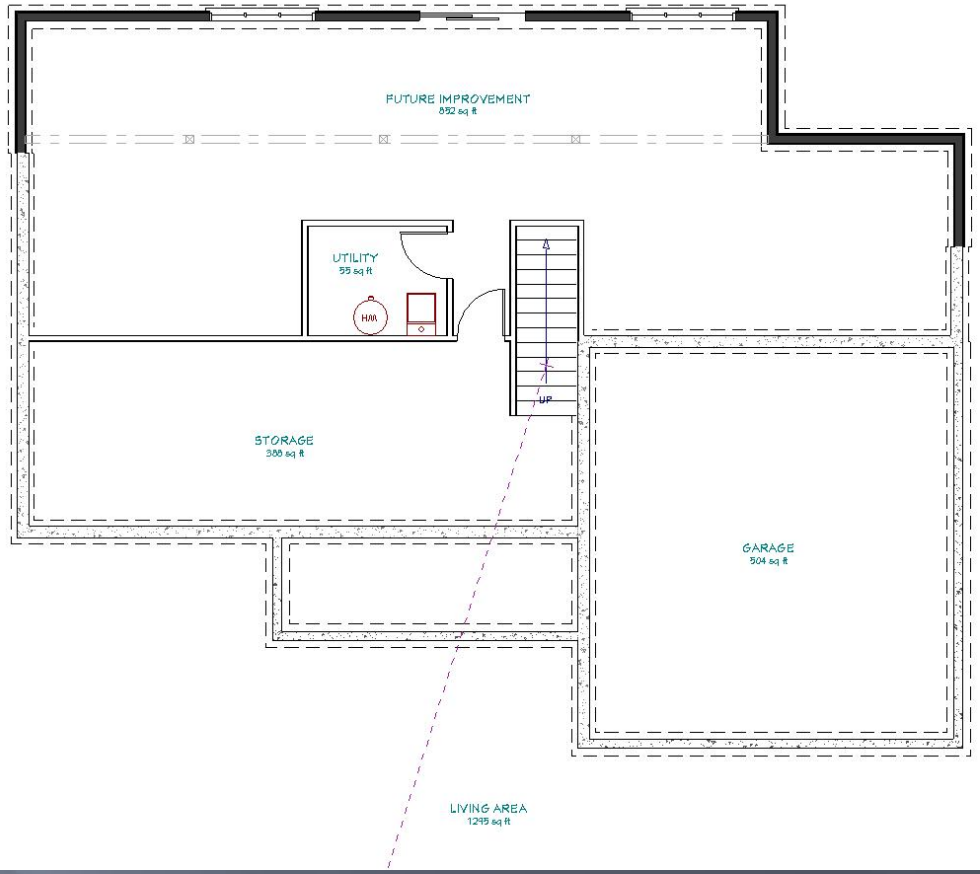
210.11(C)(4) AND 210.52(G)(1)




LiftMaster

Required receptacles

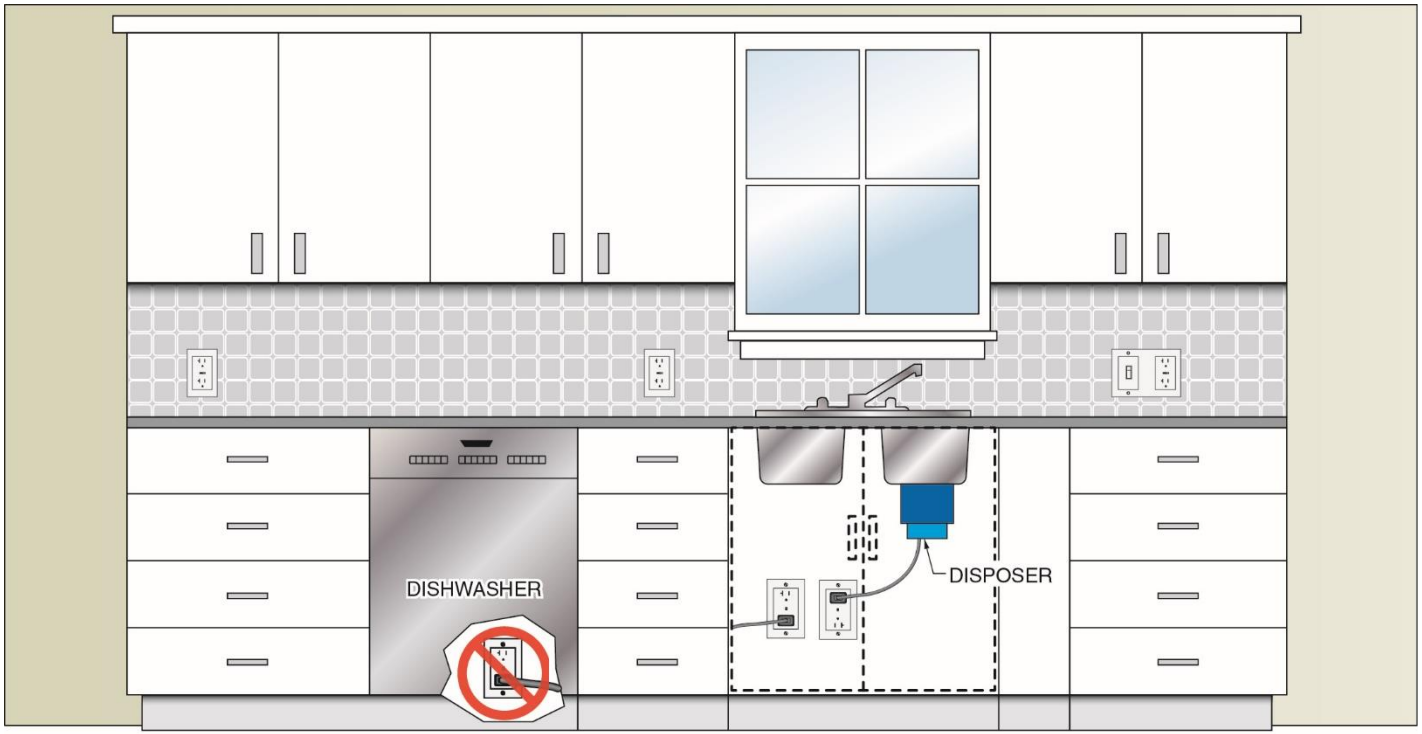
- Basement
  - One receptacle needed in addition to receptacle required for specific equipment
    - Central Vac , Sump pump
  - Each separate section is required to have a receptacle
    - Storage room
    - Partially finished basement


FUTURE IMPROVEMENT
852 sq ft
UTILITY
55 sq ft
H/W
UP
STORAGE
388 sq ft
GARAGE
504 sq ft
LIVING AREA
1295 sq ft

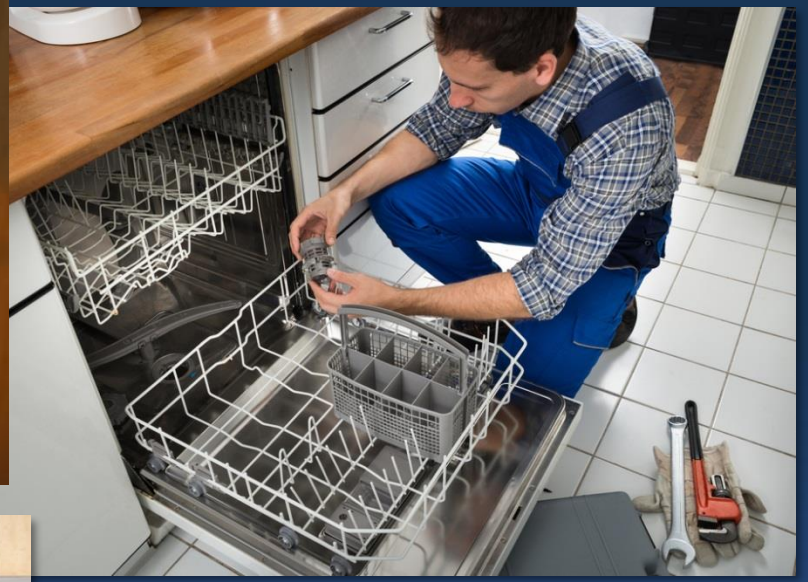
422.16(B)(2) BUILT-IN DISHWASHERS

- Built-in Dishwashers that are cord-and-plug-connected are now required to have receptacle outlet located in space adjacent to the space occupied by the dishwasher.
- Length of dishwasher cord was increased from 4 ft to 6.5 ft, “measured from the face of the attachment plug to the plane of the rear of the appliance”.
- Trash compactor cord is still required to be between 3 and 4 ft.
- Trash compactor receptacle is required to be located in adjacent space as well.

422.16(B)(2) BUILT-IN DISHWASHERS



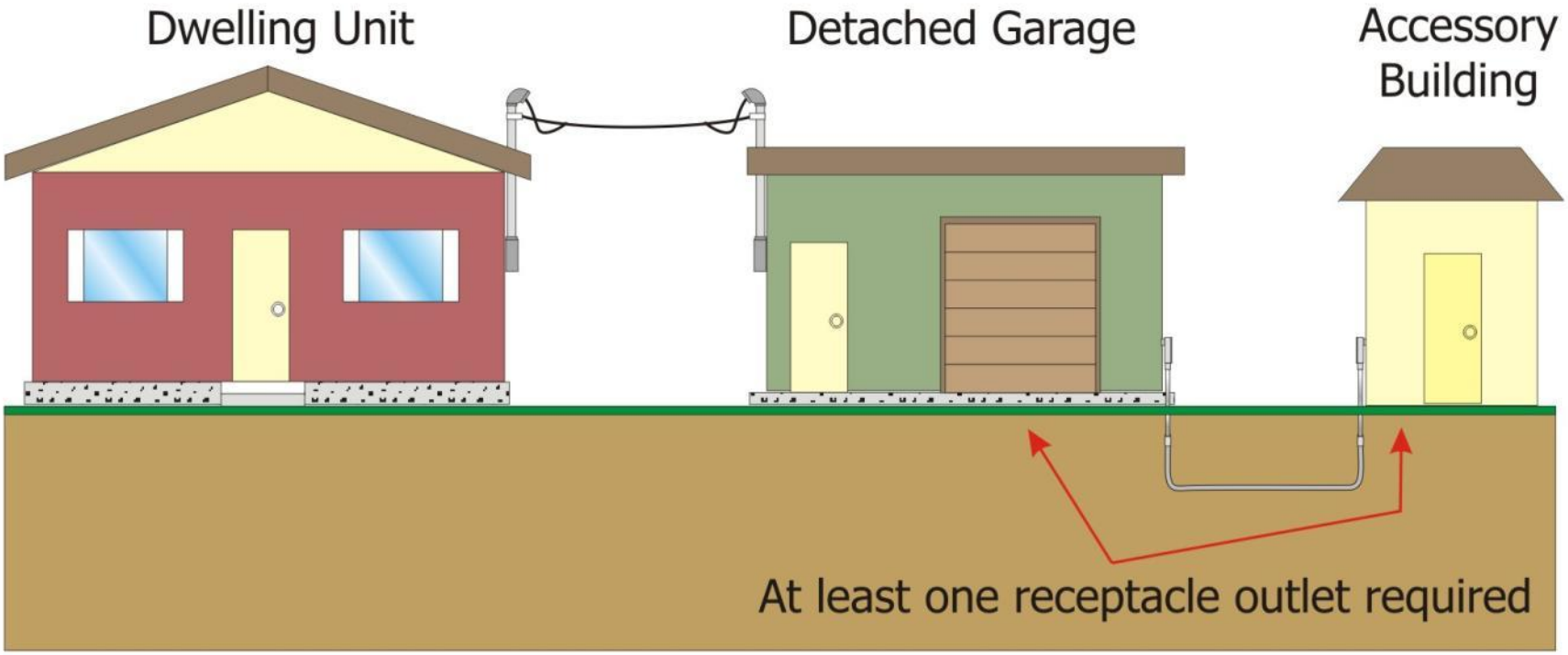
Receptacle outlet for cord-and-plug connected built-in dishwasher required to be located in the space adjacent to the space containing the dishwasher only with the length of a cord for a built-in dishwasher lengthened from 1.2 m (4 ft) to 2.0 m (6-1/2 ft)



Required receptacles

- Accessory Building(s) – (detached garage, shed, etc.)
  - Not required to run electric to any of these buildings
  - If you do run electric power, you must install a receptacle
    - Can't do lighting only
- Only 1 branch circuit allowed to be run to building
  - Multi-wire branch circuit counts as one circuit.
  - If more circuits are needed, run feeder to subpanel.

210.52(G) Accessory Buildings with Power



210.52(G) - Basements, Garages, and Accessory Buildings

At least one 125-volt, 15- and 20-ampere receptacle outlet, in addition to those for specific equipment, shall be installed in each basement, in each attached garage, and in each detached garage or accessory building with electric power

GFCI Receptacles

- Required
  - Dwelling Units – 15 and 20 amp, 120 volt
    - Bathrooms
    - Garages-*
    - Outdoors
    - Crawl spaces
    - Unfinished basements *
    - Kitchens – where the recepts are installed to serve countertops
    - Boathouses
    - Accessory buildings with floor at or below grade not intended as habitable (storage, work areas)
  - *Do not need if used for fire alarm and/or burglar alarm systems
  - **Must be READILY ACCESSIBLE**

210.8 Ground-Fault Circuit-Interrupters

- All GFCIs for personnel must be installed in a readily accessible location
- This applies to 210.8(A), (B), and (C)

GFCI Receptacles

- Required
- Dwelling Units – 15 and 20 amp, 120 volt
  - **Within 6 feet of bathtub or shower stall**
    - Eliminated loop hole
  - **All sinks – took out kitchen sink reference**
    - Could affect disposals, microwave and fridge
  - **Laundry areas**
    - Define "area"
  - **Dishwashers – 210.8(D)**

210.8 MEASUREMENTS FOR GFCI PROTECTION

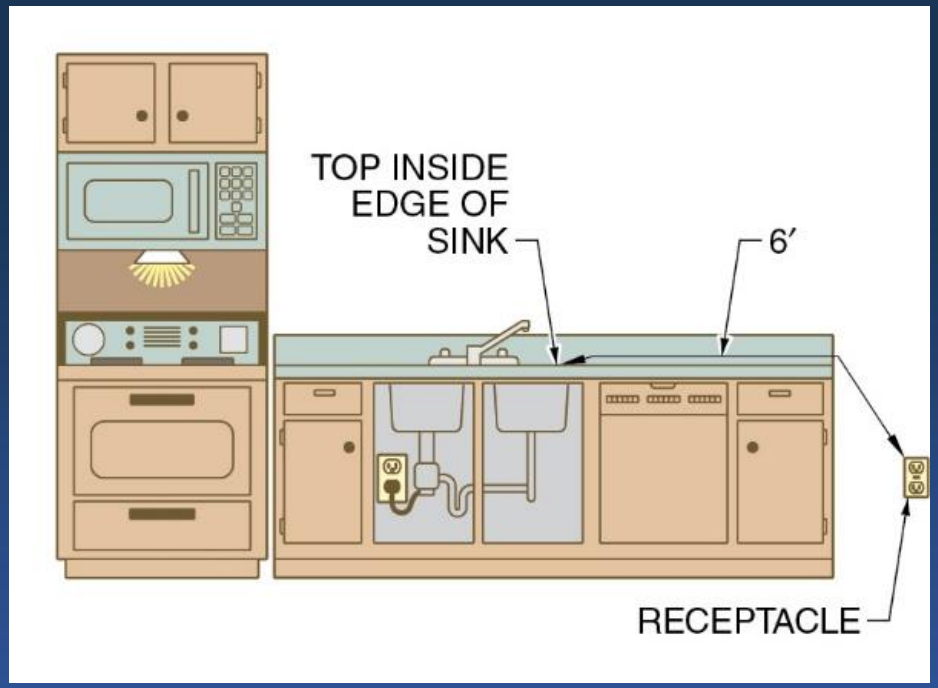
210.8 Ground-Fault Circuit-Interrupter Protection for Personnel. Ground-fault circuit-interrupter protection for personnel shall be provided as required in 210.8(A) through (E). The ground-fault circuit interrupter shall be installed in a readily accessible location.

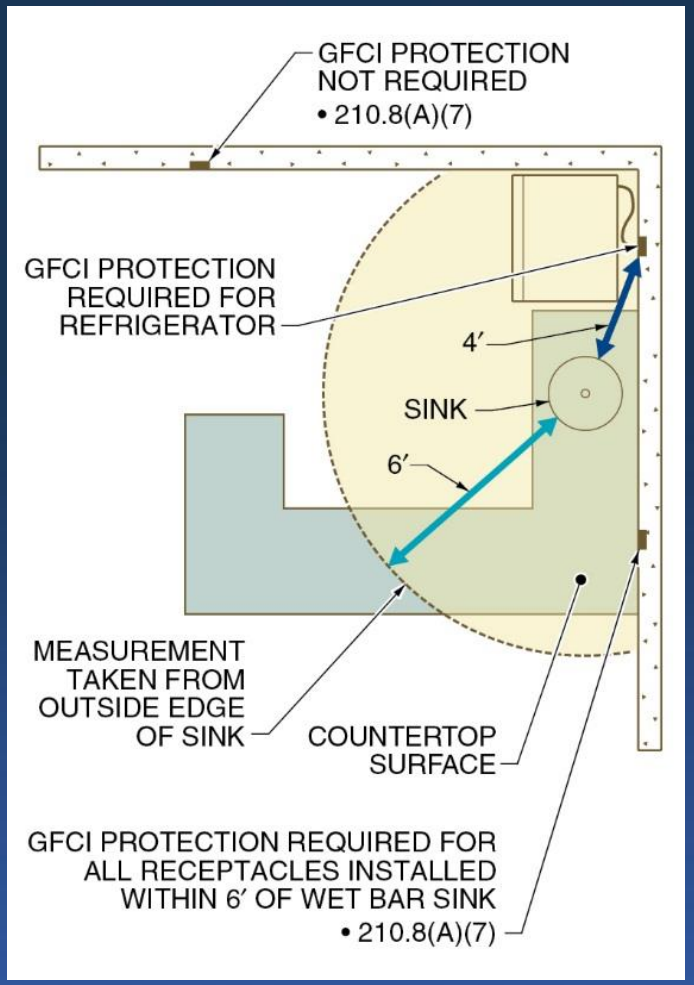
Informational Note No. 1: See 215.9 for ground-fault circuit-interrupter protection for personnel on feeders.

Informational Note No. 2: See 422.5(A) for GFCI requirements for appliances.

For the purposes of this section, when determining distance from receptacles the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

210.8 MEASUREMENTS FOR GFCI PROTECTION





210.8(A)(7) GFCI PROTECTION AT SINKS

(A) Dwellings …

(7) Sinks — where receptacles are installed within 1.8 m (6 ft) from the *top inside* edge of the bowl of the sink……

(B) Other than Dwelling Units….

(5) Sinks — where receptacles are installed within 1.8 m (6 ft) from the top inside edge of the bowl of the sink….


Inside edge of sink

SECTION 210.8(E) GFCI PROTECTION FOR CRAWL SPACE LIGHTING OUTLETS

N **(E) Crawl Space Lighting Outlets.** GFCI protection shall be provided for lighting outlets not exceeding 120 volts installed in crawl spaces.

Applies to **ALL crawl spaces**, BOTH dwelling unit and non-dwelling units alike!

Arc Fault Receptacles

- Dwelling units – 15 and 20 amp, 120 volt
  - 210.12 (A)
  - Pretty much every place that doesn't require GFCI

- Locations that don't require arc fault protection
  - Bathroom
  - Outside
  - Unfinished basement
  - Garage

Arc Fault Receptacles

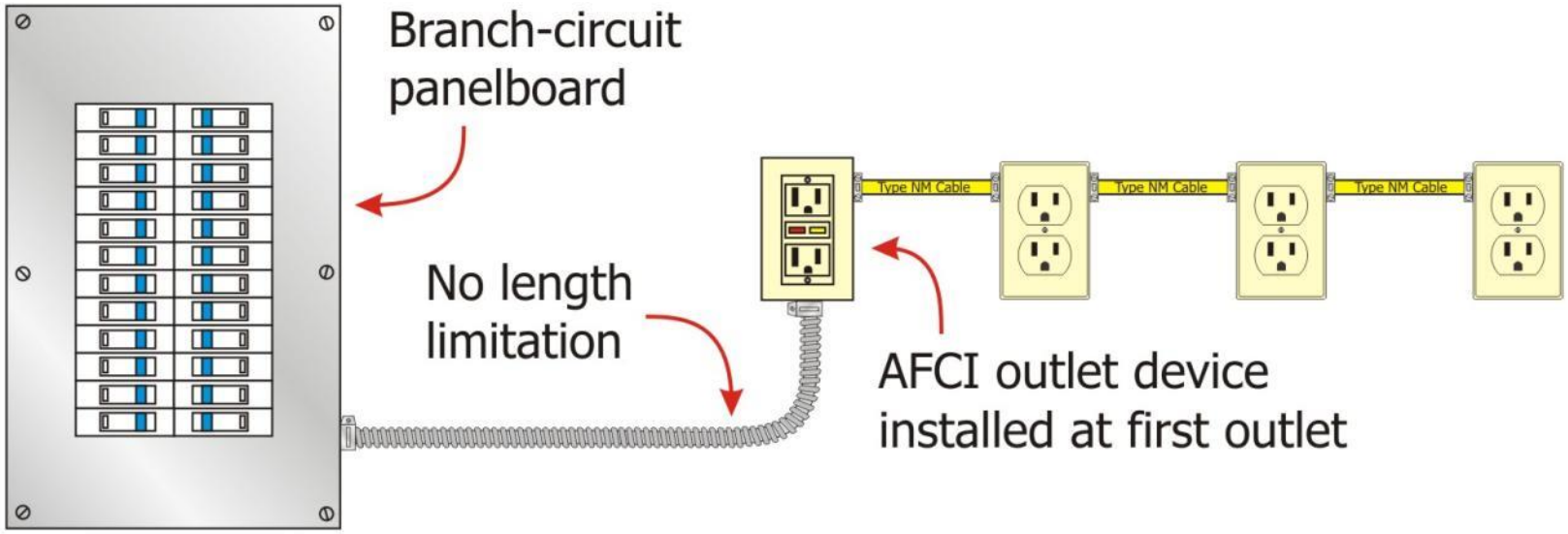
- Dwelling units – 15 and 20 amp, 120 volt
  - 210.12 (A)

- Verbiage includes the word "devices"
  - Could affect garage lighting, outdoor lighting

  - Can bypass breaker and use first outlet box if metal box and fed by metal raceway or cable.

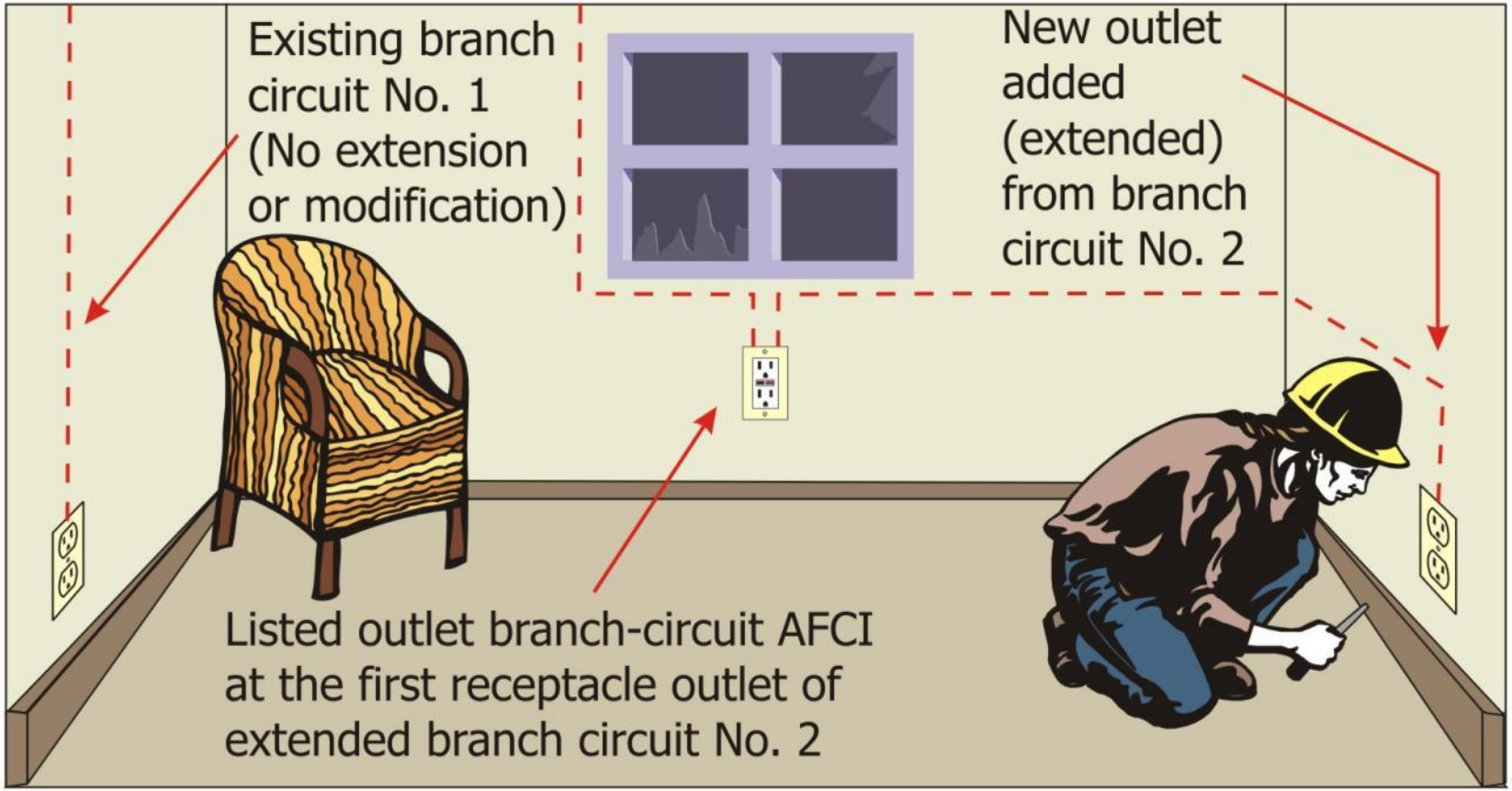
210.12(A) Ex. No. 1 Outlet Type AFCI

Main rule at 210.12(A) requires AFCI combination-type protection installed to provide protection of the entire branch circuit



Ex. No. 1: If RMC, IMC, EMT, Type MC or steel armored Type AC cables meeting the requirements of 250.118 and metal outlet and junction boxes are installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a outlet branch-circuit Type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

210.12(B) AFCI - Extensions or Modifications



In any of the areas specified in 210.12(A), where branch-circuit wiring is modified, replaced or extended, the branch circuit shall be protected by:

(1) A listed combination AFCI located at the origin of the branch circuit, or

(2) A listed outlet branch-circuit AFCI located at the first receptacle outlet of the existing branch circuit

406.4(D)(4), EX. NO. 1 AND EX. NO. 2
AFCI FOR REPLACEMENT OF EXISTING RECEPTACLES

- Four exceptions were added to this section which covers replacement of receptacles in areas that 210.12(A) and (B) now requires to have AFCI protection.
  - AFCI is not required when replacing a non-grounding receptacle and no ground exists.
  - AFCI is not required when there is not equipment ground.
  - A listed combination type arc-fault circuit-interrupter circuit breaker is not commercially available.
  - GFCI/AFCI dual function receptacles are not commercially available.
- Exception to 210.12(B) permits existing branch circuit conductors to be modified or extended up to 1.8 m (6 ft) without AFCI protection where no additional outlets or devices are installed

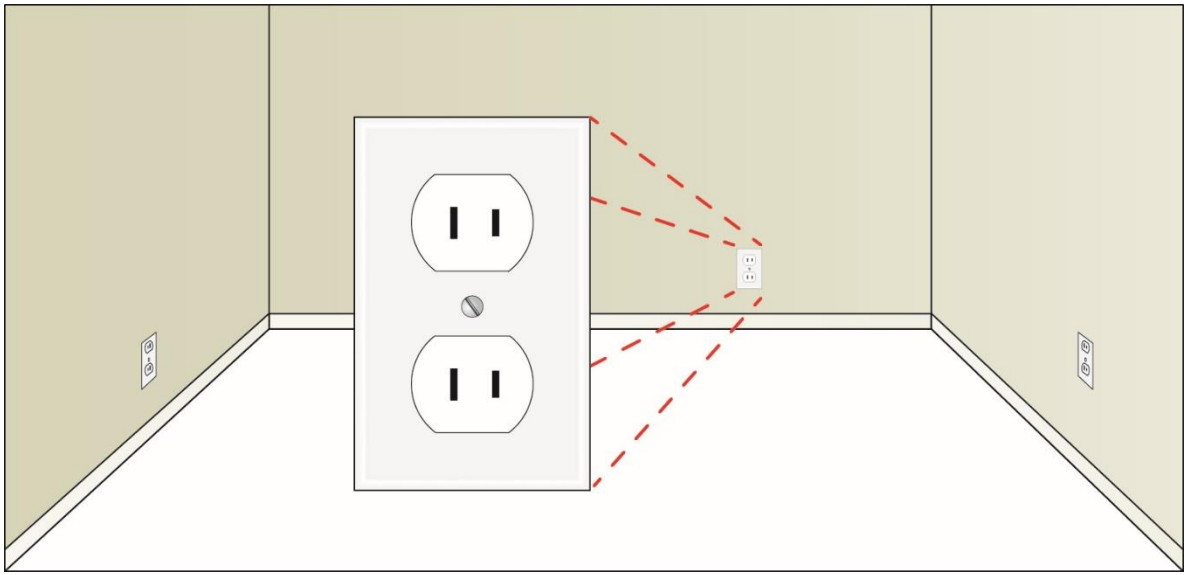
406.4(D)(4), EX. NO. 1 AND EX. NO. 2
AFCI FOR REPLACEMENT OF EXISTING RECEPTACLES

- Arc Fault replaces are not necessary if the Exception to 210.12(B) applies.

- This exception permits existing branch circuit conductors to be modified or extended up to 1.8 m (6 ft) without AFCI protection where no additional outlets or devices are installed.

406.4(D)(4) REPLACEMENT RECEPTACLES (AFCI)

Where a receptacle outlet is located in any areas specified in 210.12(A) or (B), a replacement receptacle at this outlet must be AFCI protected



Ex. No. 1: AFCI protection not required where all of the following apply:

(1) Replacement complies with 406.4(D)(2)(b) *(two-wire system-GFCI)*

(2) Impracticable to provide an EGC as provided by 250.130(C)

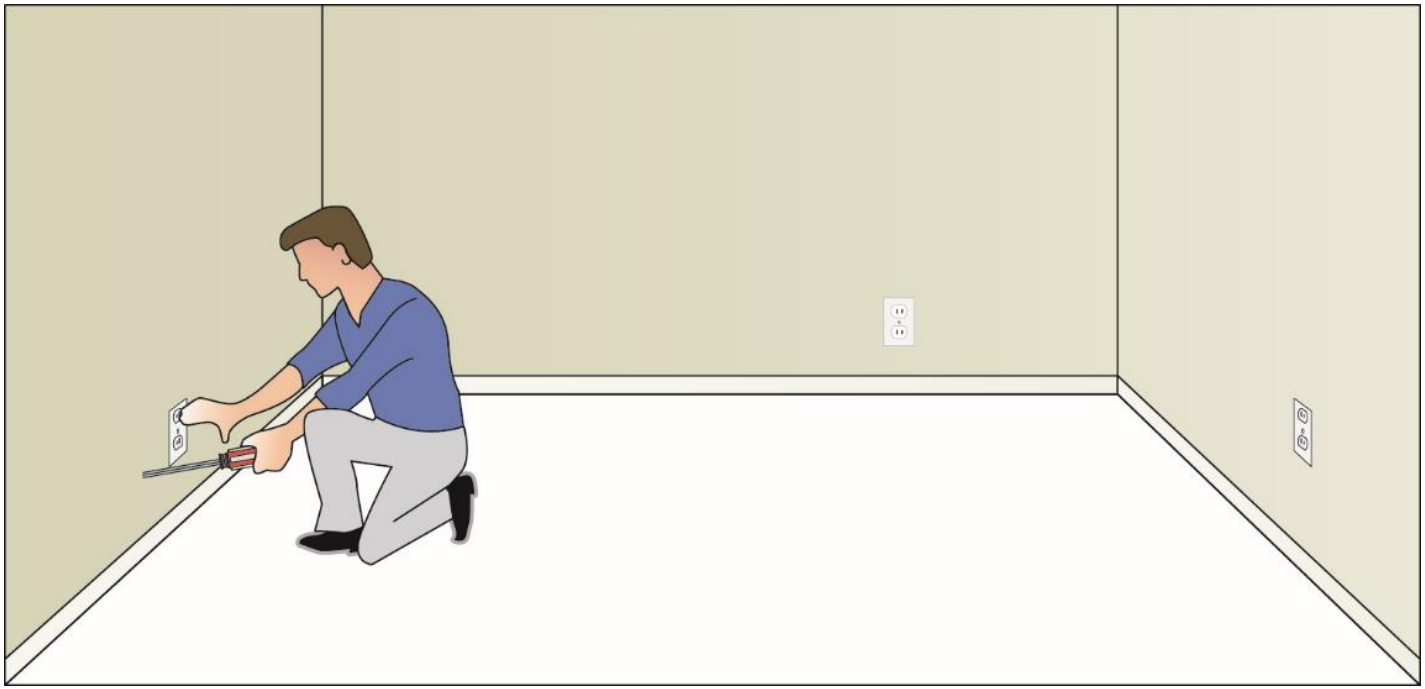
(3) Listed combination type AFCI circuit breaker not commercially available

(4) GCFI/AFCI dual function receptacles not commercially available

Ex. No. 2: Exception at 210.12(B) shall not apply to replacement of receptacl

406.4(D)(4) REPLACEMENT RECEPTACLES (AFCI)

Where a receptacle outlet is located in any areas specified in 210.12(A) or (B), a replacement receptacle at this outlet must be AFCI protected



Ex. No. 2: Exception at 210.12(B) shall not apply to replacement of receptacles

[210.12(B), Ex.: AFCI protection not required where the extension of the existing conductors is not more than 1.8 m (6 ft.) and does not include any additional outlets or devices]

Required switches

- At least one wall switch controlled lighting outlet in each habitable room
  - Outlet is not the same as a receptacle
    - Overhead light
    - Wall sconce
  - Sensors are allowed if manual override available
- It may be a receptacle instead of a lighting outlet (overhead light) except for
  - Kitchen
  - Bathroom
  - Garage

Required switches

- Hallways – at least one switch
- Storage or equipment spaces
  - Attics, under floor spaces, utility rooms, basements
  - At least one switch
    - Switch near point of entry
    - Lighting outlet near equipment needing servicing
- Stairs
  - One at each level if there are 6 or more risers
  - One at each level if it is an entryway
- Exterior of exterior doors with grade level access
  - Coach lights
  - Does not include a vehicle door (garage door)

Required switches

- 2011 required a neutral to be in most switch boxes
  - Hoped to reduce having ground used as conductor
- Rules loosened up a little in 2014
  - Neutral not needed if:
    - Switch does not serve a habitable room or bathroom
      - Hallway
      - Closets
    - Multiple switching (3 ways and 4 ways)
      - Only need where switch location covers the area
    - Integral switches
      - Door jam switch
- Also kept other exceptions:
  - Raceways
  - Access to switch box at later time

404.2(C) GROUNDED CONDUCTOR AT SW. LOCATIONS

(C) Switches Controlling Lighting Loads. The grounded circuit conductor for the controlled lighting circuit shall be installed at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit serving bathrooms, hallways, stairways, or rooms suitable for human habitation or occupancy as defined in the applicable building code. Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations, the grounded circuit conductor shall only be required at one location.

404.2(C) Grounded Conductor at Switch Locations

A grounded conductor is generally required to be installed and connected to the switching device at locations where switches control lighting loads that are supplied by a grounded general purpose-branch circuit.

Grounded conductor is generally NOT required at the following locations:

Lighting controlled by automatic means

Where a switch controls a receptacle load

Switch for non-habitation type room or occupancies as defined by applicable building codes

404.2(C) GROUNDED CONDUCTOR AT SWITCH LOCATIONS

A grounded conductor is generally required to be installed and connected to the switching device at locations where switches control lighting loads that are supplied by a grounded general-purpose branch circuit

Grounded is generally **NOT** required at the following locations:

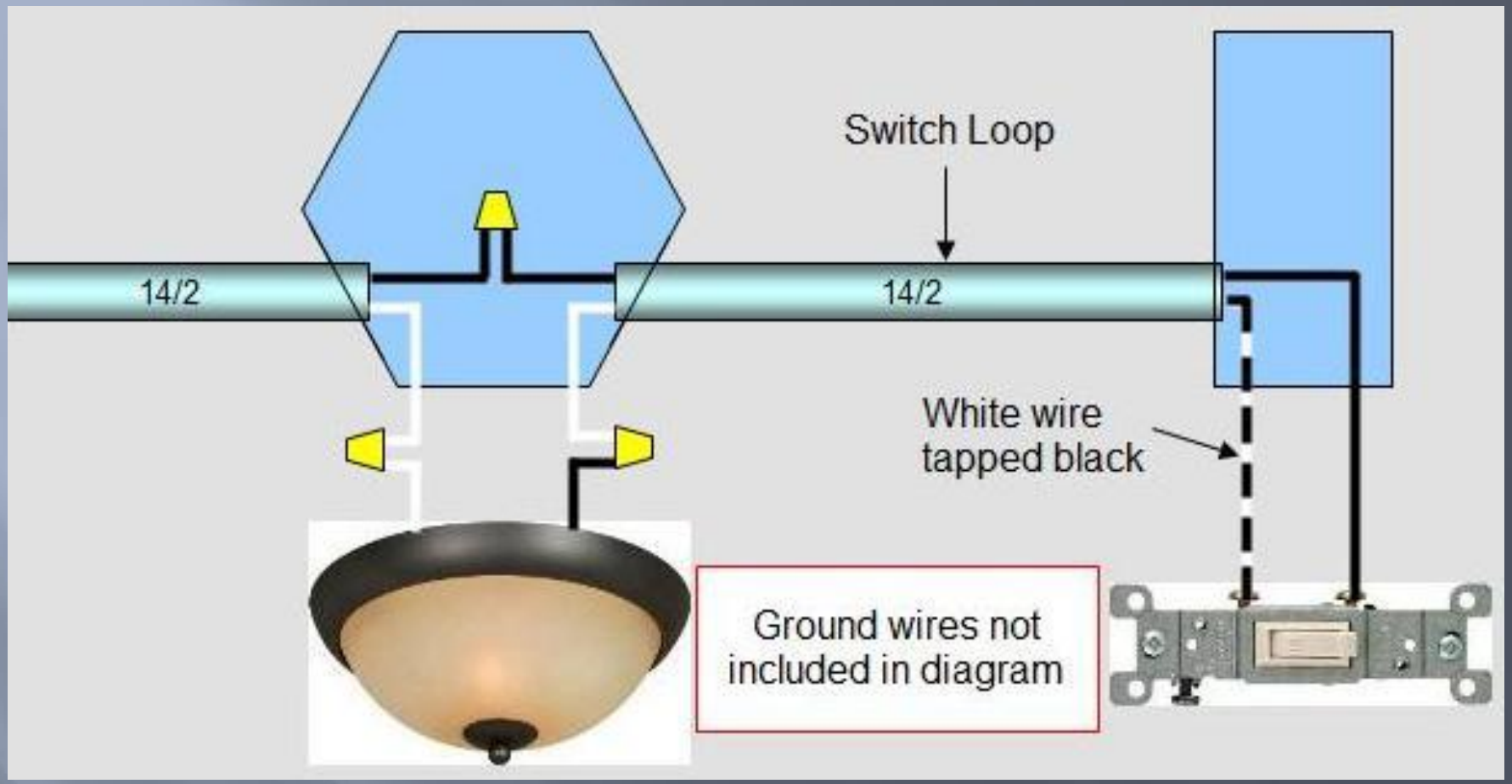
Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations, the grounded circuit conductor shall only be required at one location

404.2(C) SWITCHES CONTROLLING LIGHTING LOADS

- All electronic lighting control switches are required to be listed. As of Jan. 1, 2020, electronic lighting control switches (with exceptions) will not be permitted to introduce current on the equipment-grounding conductor during normal operation.
- Manufacturers will only make devices that place current on the equipment-grounding conductor during normal operation for replacement/retrofit.
- New exception places limits to electronic switches to the following levels.
  - Branch circuit (5)
  - Or feeder (25)

Required switches

- Switch loops required to be:
  - Down on white
  - Back on black
- Must phase white conductor with phase color
  - Tape
  - Paint
  - Marker
- Not as relevant with neutral requirements

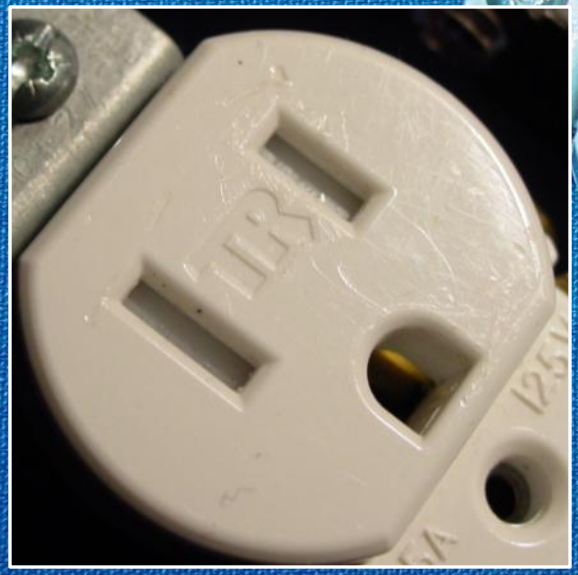

Switch Loop
14/2
14/2
White wire
tapped black
Ground wires not
included in diagram

Devices- General

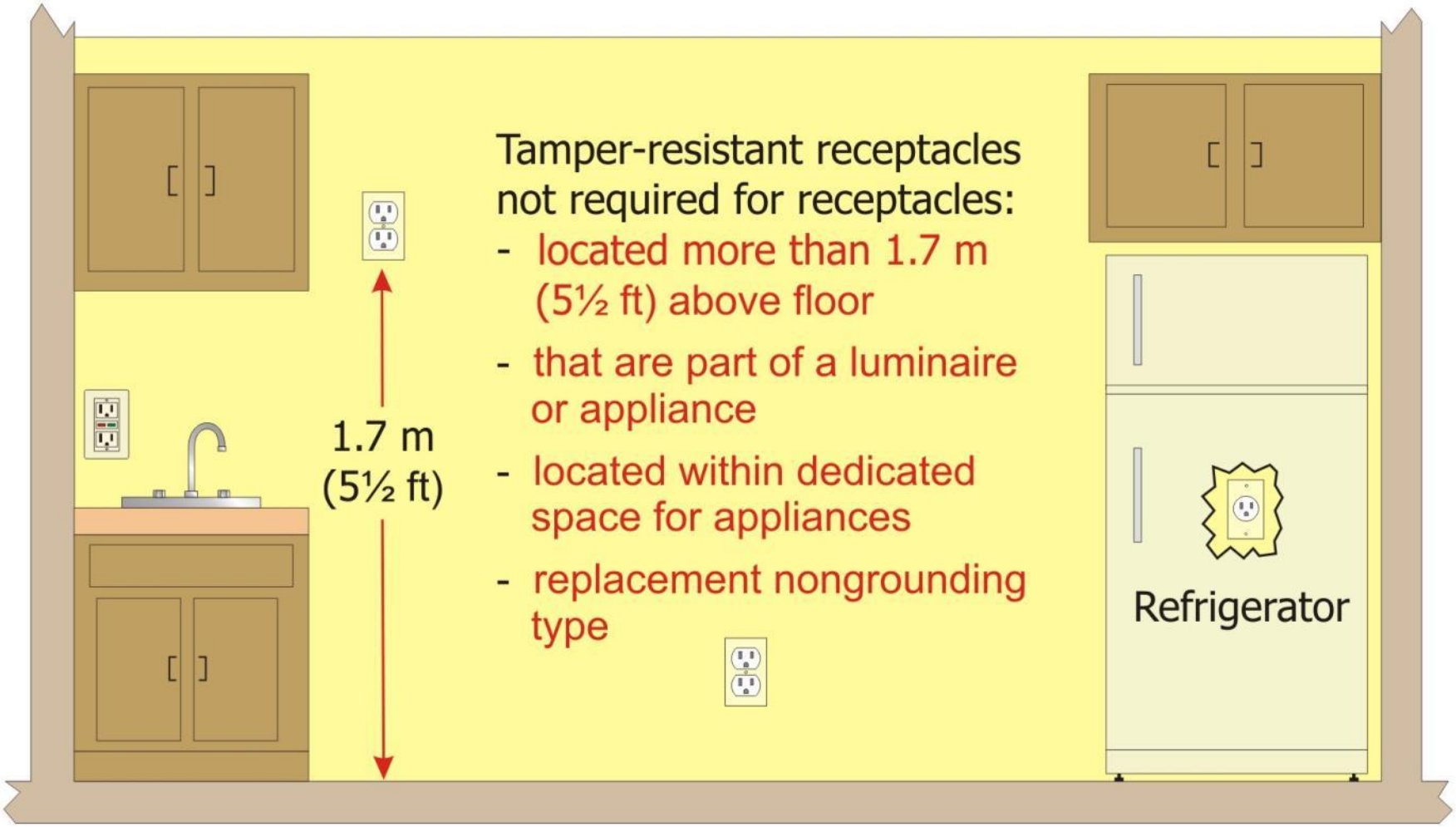
- Tamper resistant receptacles
  - Required for all 120 volt, 15 and 20 amp receptacles
    - Not required 5 ½ feet off the floor and below or dedicated for appliance.
- Weather resistant receptacles
  - Required for all outdoor receptacles
- **Extra Duty Covers**
  - Must be used in all wet locations
  - Can not be old gasket type
- CO/ALR
  - Listed for both copper and aluminum wire

Replacement receptacles must be brought up to code regarding tamper and weather resistant. There is also provisions for bringing the circuit up to arc fault standards.


EXTRA DUTY
LIFT
OPEN



406.12 Tamper-Resistant Receptacles



In all areas specified in 210.52, all nonlocking type 125-volt, 15- and 20-ampere receptacles required to be listed tamper-resistant receptacles

406.4(D)(4) Receptacle Replacement (AFCI)

Arc-fault circuit-interrupter protection is required for replacement receptacle outlets where a receptacle outlet is supplied by a branch circuit that requires AFCI protection elsewhere in the *Code* *(effective date January 1, 2014)*

Replacement receptacle outlet can be protected by a listed outlet branch circuit type AFCI receptacle or a listed combination type AFCI circuit breake

406.4(D)(5) Receptacle Replacement Tamper-Resistant Receptacles

Listed tamper-resistant receptacles are required for replacement receptacle outlets where a receptacle outlet is required to be tamper-resistant elsewhere in the *Code*

See 406.12, 406.13, and 406.14 for tamper-resistant receptacle requirements

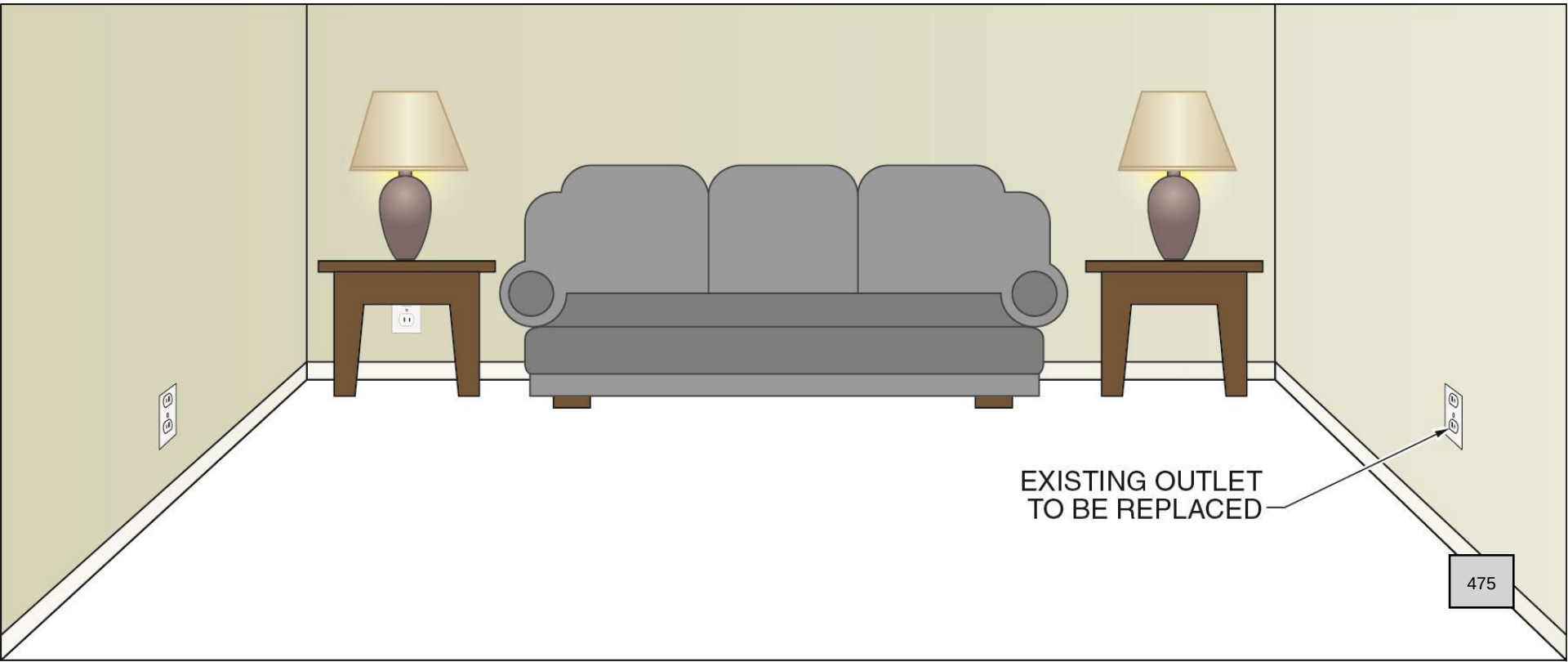
TAMPER-RESISTANT RECEPTACLES FOR REPLACEMENTS

- Tamper-resistant receptacles are presently not manufactured in a nongrounding type, two-prong receptacle

- Therefore, when replacing receptacles, tamper-resistant receptacles are required for all replacements in those areas required by the code unless a non-grounding receptacle is replaced with another non-grounding receptacle type.

406.4(D)(5) REPLACEMENT WITH TAMPER RESISTANT

(5) Tamper-Resistant Receptacles. Listed tamper-resistant receptacles shall be provided where replacements are made at receptacle outlets that are required to be tamper-resistant elsewhere in this Code, except where a non-grounding receptacle is replaced with another non-grounding receptacle.



406.4(D)(6) Receptacle Replacement Weather-Resistant Receptacles

Listed weather-resistant receptacles are required for replacement receptacle outlets where a receptacle outlet is required to be weather-resistant elsewhere in the *Code*

See 406.9(A) and 406.9(B) for weather-resistant receptacle requirements

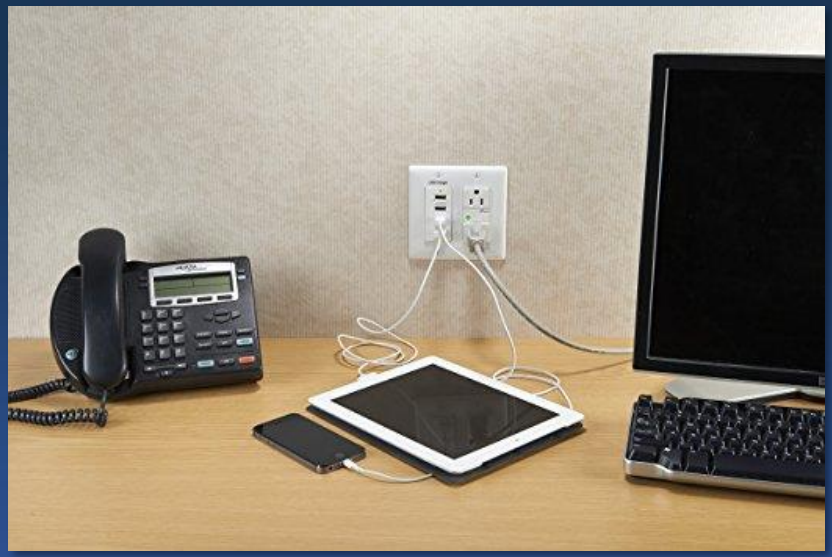
406.3(F) RECEPTACLE WITH USB CHARGER

- New Text has been added to clarify the when USB Charging ports are integral to a 125-volt, 15- or 20- amp receptacle the Class 2 circuitry necessary for the USB charging is integral to the receptacle.

- Receptacle shall be listed.

- Certain Class 2 power supplies and output connector(s) are intended to be secured and directly connected to a duplex receptacle. This is not permitted according to the new text.

RECEPTACLE WITH USB CHARGER

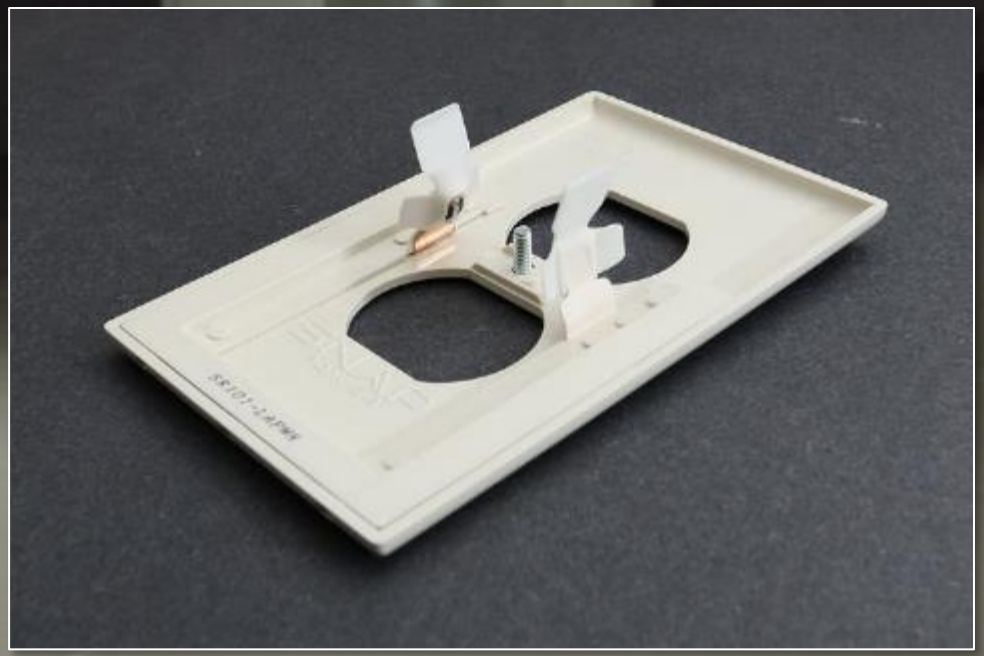


406.6(D) RECEPTACLE FACEPLATE (COVER PLATES) WITH INTEGRAL NIGHT LIGHT AND/OR USB CHARGER

- New requirements were added pertaining to receptacle faceplates with integral night lights and/or USB chargers
- These faceplates must be listed and constructed such that the night light and/or Class 2 circuitry is “integral with the flush device cover plate”
- Plug-in night light/covers that is not “integral with the flush device cover plate,” but simply designed to be plugged directly into a receptacle outlet presents a problem
- The ease in removing these night light-type covers from the receptacle outlet increases its safety hazard

406.6(D) Receptacle Faceplate (Cover Plates) with Integral Night Light and/or USB Charger.

A flush device cover plate that additionally provides a night light and/or Class 2 output connector(s) shall be listed and constructed such that the night light and/or Class 2 circuitry is integral with the flush device cover plate.



SnapPower

Required lighting

- Lighting fixtures
  - Bathtub and shower
    - No part of fixture shall be located within
      - 8’ vertically from top of bathtub rim or shower thresh hold
      - 3’ horizontally from edge of fixture
    - If located within this zone, must be marked for damp/wet location (can light, weatherproof trim)

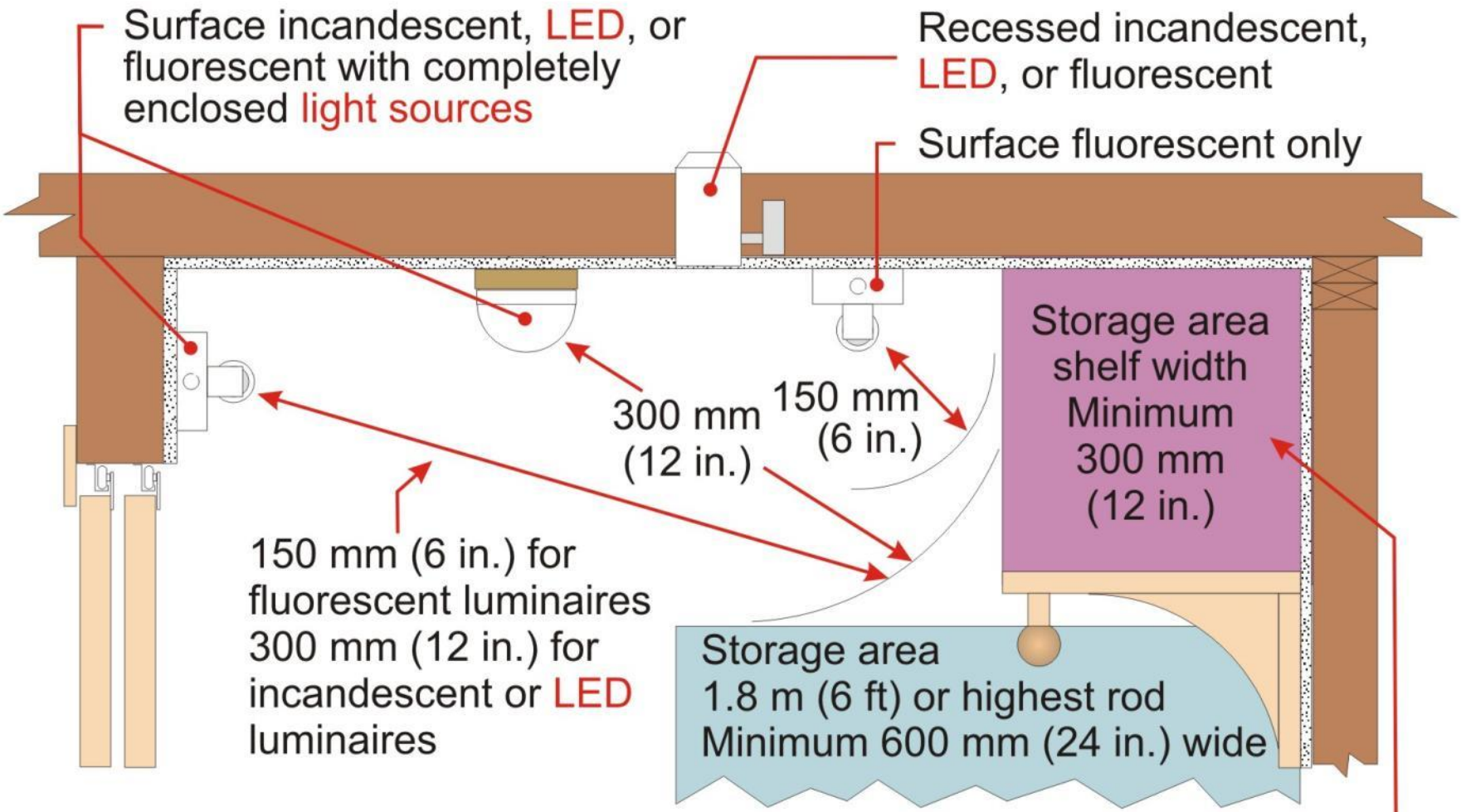
Required lighting

- Clothes closets
  - Open lamps not allowed

- Zone extends from edge of shelf to ceiling
  - 12” clearance for surface mounted incandescent lamp completely enclosed
  - 6” clearance for surface mount fluorescent, or recessed light.
  - LED lights allowed if completely enclosed or listed for closets

- White can – 3” from insulation,
- Metal can – insulation can come in contact

410.16 Luminaires in Clothes Closets



Surface-mounted fluorescent or LED luminaires permitted to be installed within the closet storage space where identified for this use

Revisions were added to 410.16 to clearly permit surface-mounted LED luminaires in clothes closets

Disconnecting Means

- Needed for appliances/motors
  - In sight and within 50'
- Common disconnects
  - Furnace
  - Dishwasher
  - Oven
  - Central Vac
  - AC unit
  - Dryer
- Can be switch or receptacle
- AC unit does not have to be fused – if breaker is correct

- MUST SIMULTANEOUS DISCONNECT ALL PHASE CONDUCTORS OF AN APPLIANCE

Pools/Hot tubs/Jacuzzis

- Dwelling Pools
  - At least one receptacle located between 6’-20’ from inside edge of pool shall be provided
  - Located 6’6” or less above grade level
  - Must be GFCI protected
  - Pool pump must be GFCI protected
    - 120 or 240 volt
  - Must have insulated ground throughout circuit for light fixtures
  - Receptacle for hydro massage tub must be within one foot of the opening of the access panel with its face in direct view.

Pools/Hot tubs/Jacuzzis

- Dwelling hot tub
  - Receptacle required between 6 and 10 feet
  - Must be GFCI protected
  - Power to hot tub must be GFCI protected
- Lighting outlets, paddle fans, etc.
  - If not GFCI protected
  - Located at least 12 feet above maximum water level
  - If GFCI protected
  - Located at least 7 foot 6 above maximum water level
- Specialty fixtures may be allowed lower clearance if GFCI protected.

Smoke Detectors

- Must have one on each floor
- If placed on ceiling, keep off wall by at least 12”
- If placed on wall, mount between 4” and 12” of ceiling

- Every bedroom and common hallway is required to have one

- Must be interconnected (3 wire)

- Do not place near kitchen, bathroom, garage, utility room unless it is rated for it. Could use rate of rise or heat detector instead
- Do not put near register vents or ceiling fans.

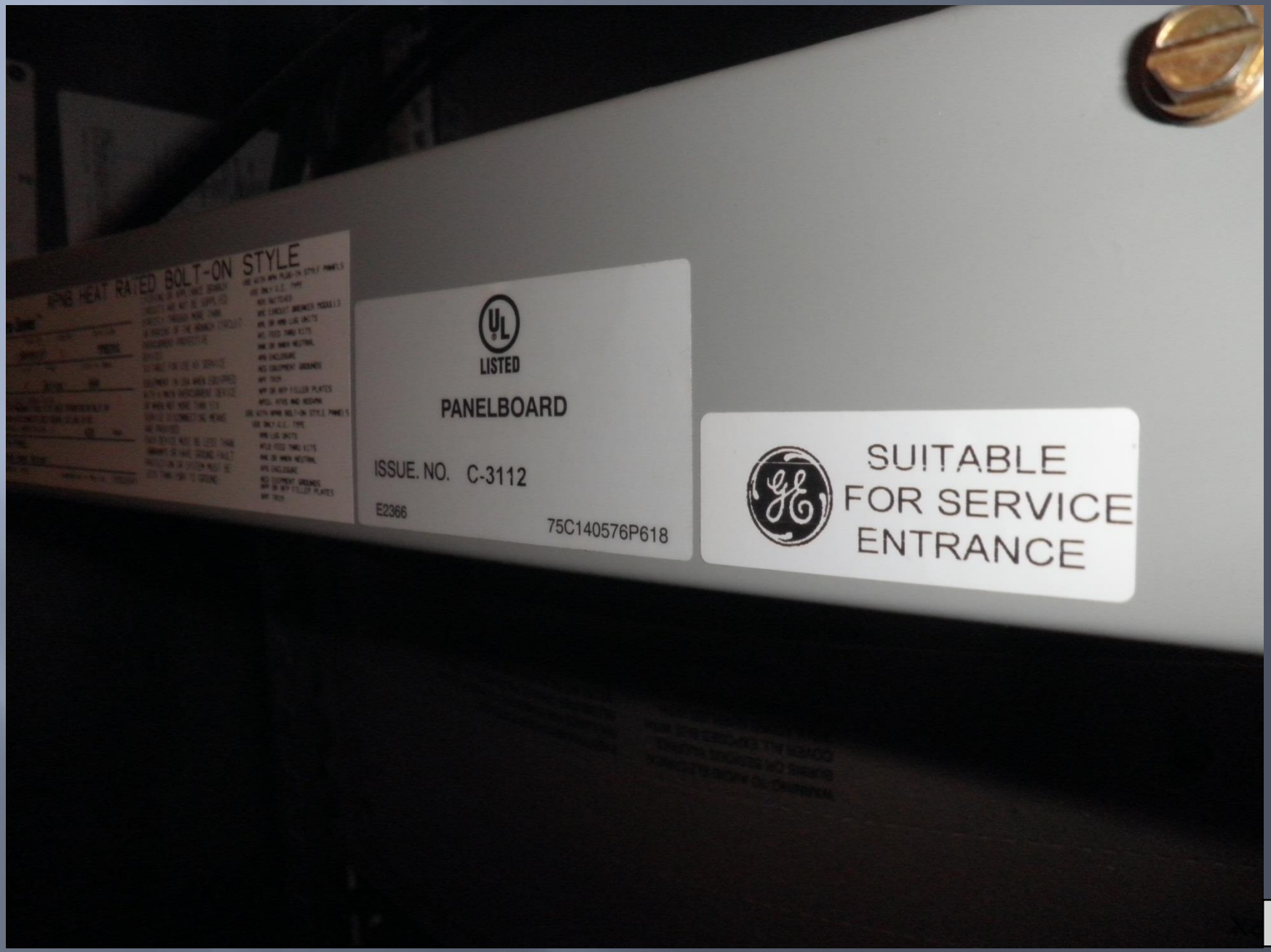
2017 RESIDENTIAL N.E.C. REQUIREMENTS

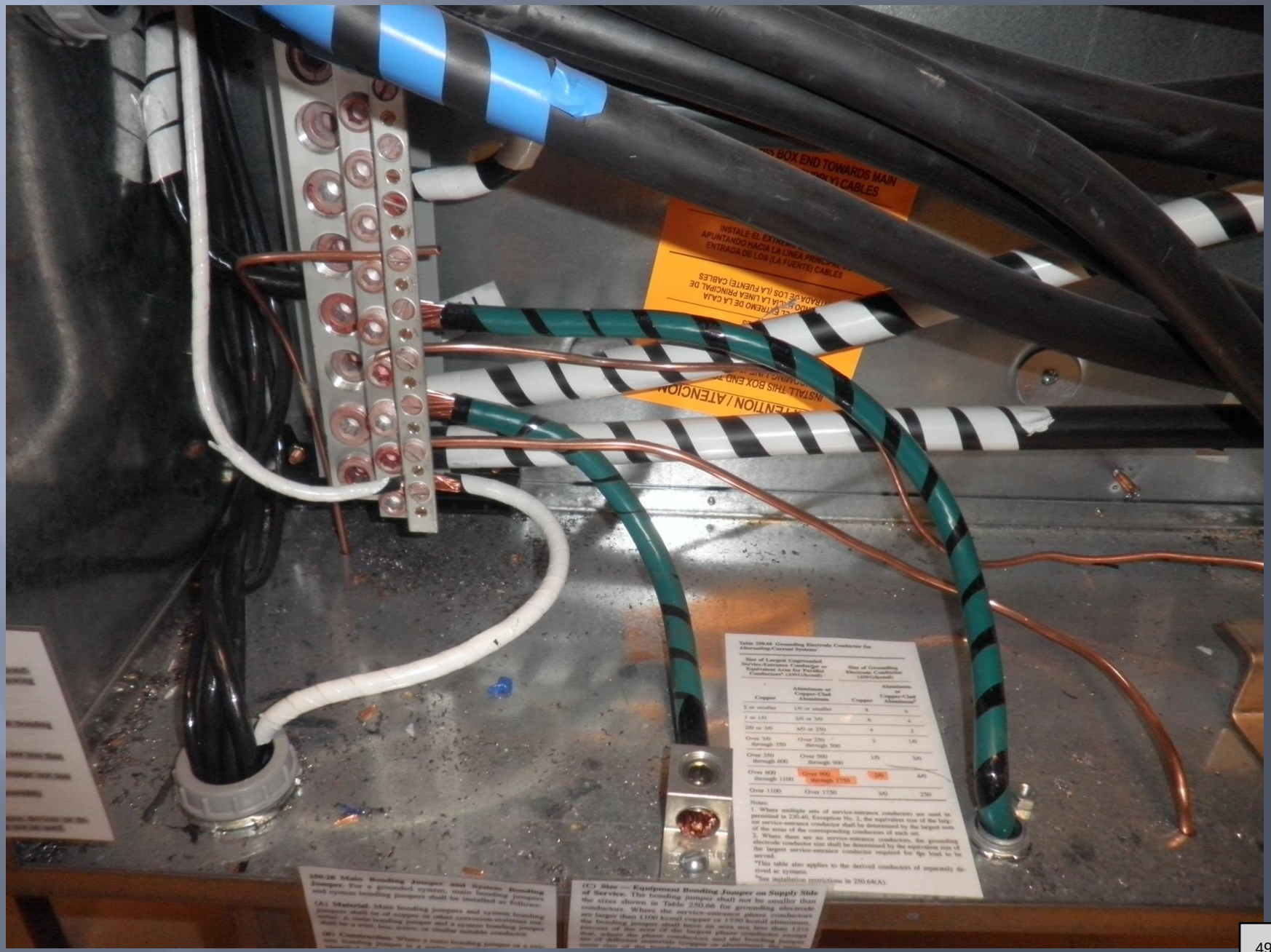
Services - general

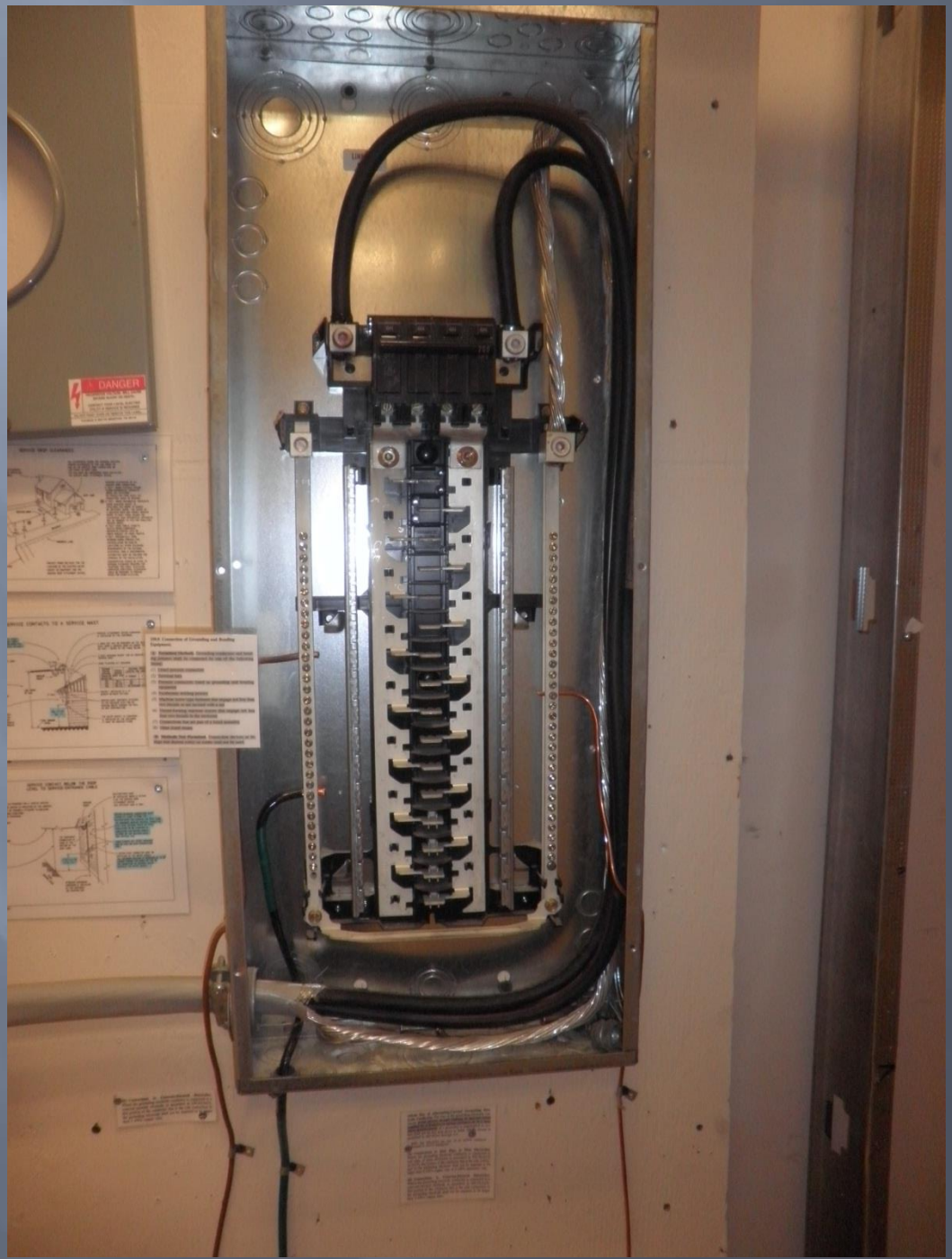
- 230.2 – Only one service per building
  - Several exceptions – unlikely to apply to dwellings
    - Too large
    - Different voltages
    - Different rate schedules

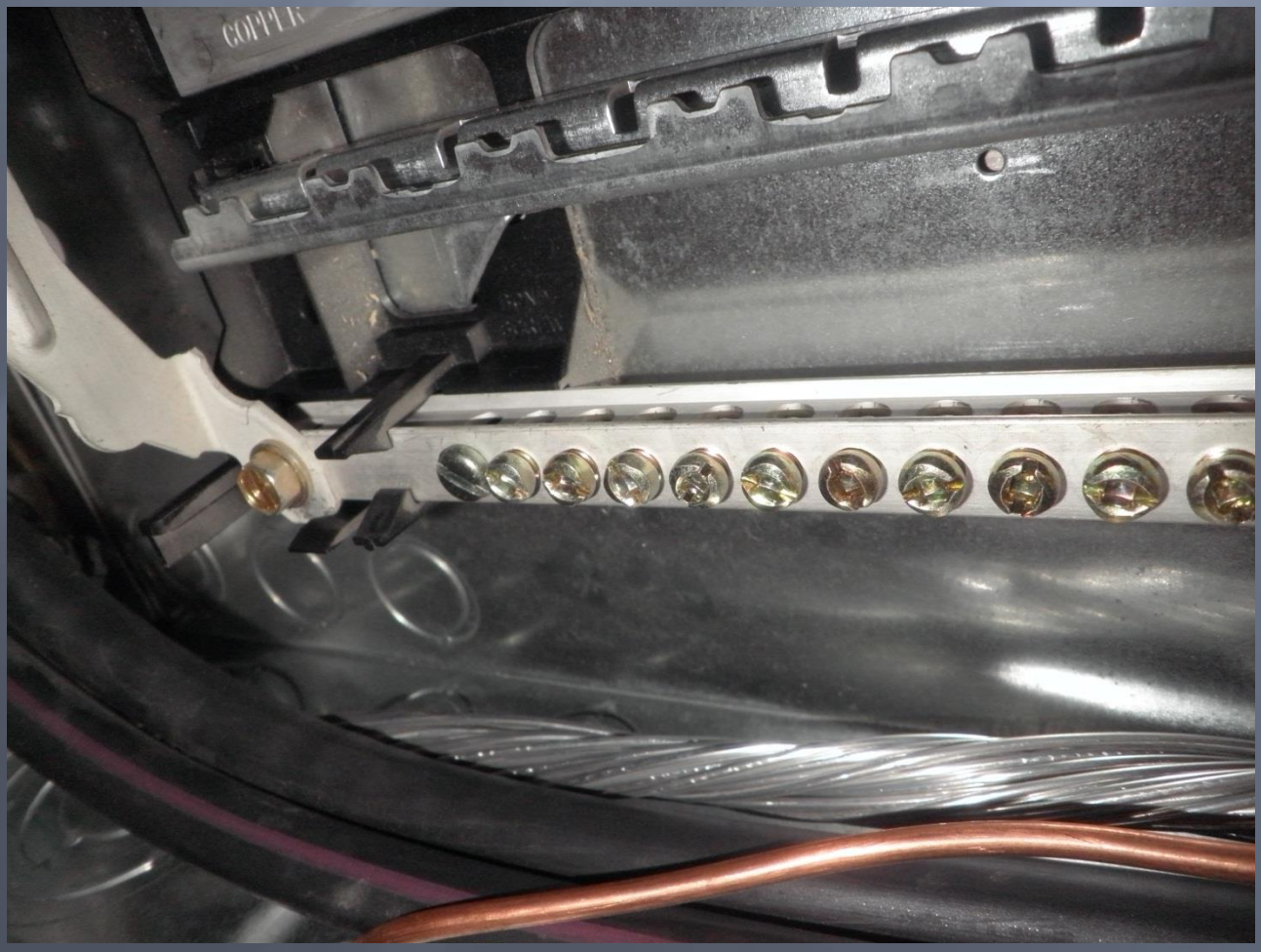
Services - general

- Must be suitable for service entrance equipment
- Bonding ground and neutral
  - Only one time
- Main breaker must be secured in place
  - Wording is back fed devices – 408.36(D)
- Height of main breaker 6’7” to top – 404.8(A)


HEAT RATED BOLT-ON STYLE
LISTED
PANELBOARD
ISSUE. NO. C-3112
E2366
75C140576P618
SUITABLE
FOR SERVICE
ENTRANCE


BOX END TOWARDS MAIN
CABLES
INSTALE EL EXTREMO DE LA CAJA
APUNTANDO HACIA LA LINEA PRINCIPAL DE
ENTRADA DE LOS (LA FUENTE) CABLES
INSTALL THIS BOX END TOWARDS MAIN
Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems
Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors* (AWG/kcmil)
Size of Grounding Electrode Conductor (AWG/kcmil)
Copper
Aluminum or Copper-Clad Aluminum
2 or smaller
1/0 or smaller
6
4
1 or 1/0
2/0 or 3/0
4
2
2/0 or 3/0
4/0 or 250
2
1/0
Over 3/0 through 350
Over 250 through 500
1/0
3/0
Over 350 through 600
Over 500 through 900
2/0
4/0
Over 600 through 1100
Over 900 through 1750
3/0
250
Over 1100
Over 1750
3/0
250
Notes:
1. Where multiple sets of service-entrance conductors are used as permitted in 230.40, Exception No. 2, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.
2. Where there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.
*This table also applies to the derived conductors of separately derived ac systems.
**See installation restrictions in 250.64(A).
250.28 Main Bonding Jumper and System Bonding Jumper. For a grounded system, main bonding jumpers and system bonding jumpers shall be installed as follows:
(A) Material. Main bonding jumpers and system bonding jumpers shall be of copper or other corrosion-resistant material. A main bonding jumper and a system bonding jumper shall be a wire, bus, screw, or similar suitable conductor.
(B) Construction. Where a main bonding jumper or a system bonding jumper is a screw only, the screw shall be identified with a green finish that shall not be readily removable.
(C) Size — Equipment Bonding Jumper on Supply Side of Service. The bonding jumper shall not be smaller than the sizes shown in Table 250.66 for grounding electrode conductors. Where the service-entrance phase conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the bonding jumper shall have an area not less than 12½ percent of the area of the largest phase conductor, except that, where the phase conductors and the bonding jumper are of different materials (copper or aluminum), the minimum size of the bonding jumper shall be based on the


DANGER



Services - Clearances

- 230.24 (B) Vertical Clearance
- Voltages are one phase to ground
  - 10 feet
    - Pedestrian only, 150 volts to ground
  - 12 feet
    - Not subject to truck traffic, 300 volts to ground
  - 15 feet
    - Same as 12, over 300 volts to ground
  - 18 feet
    - Over public streets, subject to truck traffic
  - 24 ½ feet
    - Over railroad tracks

(B) Vertical Clearance for Overhead Service Conductors. Overhead service conductors, where not in excess of 600 volts, nominal, shall have the following minimum clearance from final grade:

(1) 3.0 m (10 ft) — at the electrical service entrance to buildings, also at the lowest point of the drip loop of the building electrical entrance, and above areas or sidewalks accessible only to pedestrians, measured from final grade or other accessible surface only for overhead service conductors supported on and cabled together with a grounded bare messenger where the voltage does not exceed 150 volts to ground

(2) 3.7 m (12 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground

(3) 4.5 m (15 ft) — for those areas listed in the 3.7-m (12-ft) classification where the voltage exceeds 300 volts to ground

(4) 5.5 m (18 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land such as cultivated, grazing, forest, and orchard

Services - Clearances

- 230.9 – Clearances on buildings
  - Open conductors – 3 feet from attainable locations
    - Exception – above a window
  - Vertical Clearance – platforms, etc.
  - Roofs
    - 8 feet – normal roofs – maintained for 3 feet in all directions
      - Exception 1 – pedestrian traffic (patio, etc.)
        - Then normal clearances
      - Exception 2 - only 3 feet needed
        - Less than 300 volts
        - 4/12 slope


www.checkthishouse.com

Services – Conductor Installation

- 230.50 (1) – Underground protection against physical damage when emerging from grade
  - Rigid metal, IMC, Schedule **80** PVC, EMT

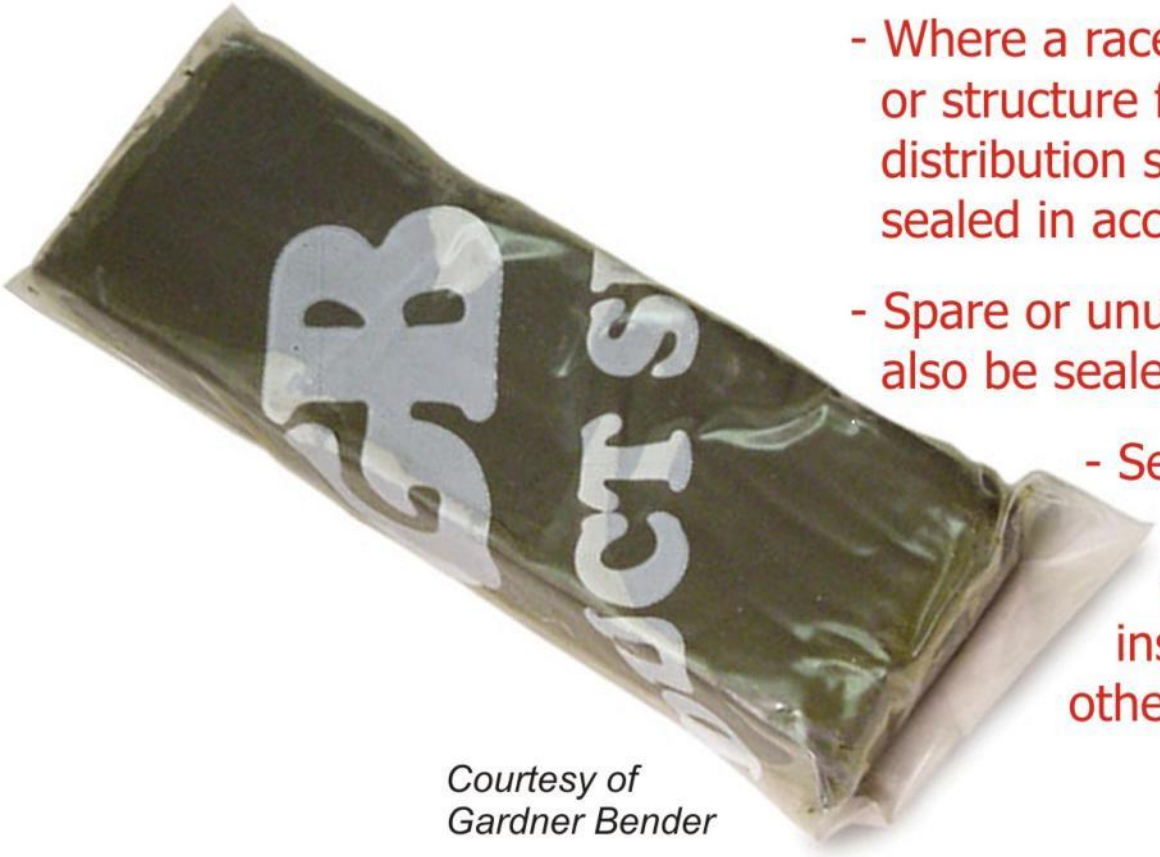
Services - Underground

- 300.5 Underground Installations
  - (D)(1) Emerging from grade
    - 8 feet above
    - 18 inches below
  - (D)(3) Service conductors
    - If not in concrete and buried 18 inches or more
      - Warning ribbon – 12 inches above conductors
  - (F) Backfill – clean
  - (J) Earth Movement – "S" loops

If conduit enters building from outside, it must be sealed

225.27 Raceway Seal

A raceway seal is required at outside underground branch circuit and feeder raceways entering a building



Courtesy of Gardner Bender

- Where a raceway enters a building or structure from an underground distribution system, it shall be sealed in accordance with 300.5(G)
- Spare or unused raceways shall also be sealed
- Sealants shall be identified for use with the cable insulation, shield or other components

505

Services – Conductor Installation

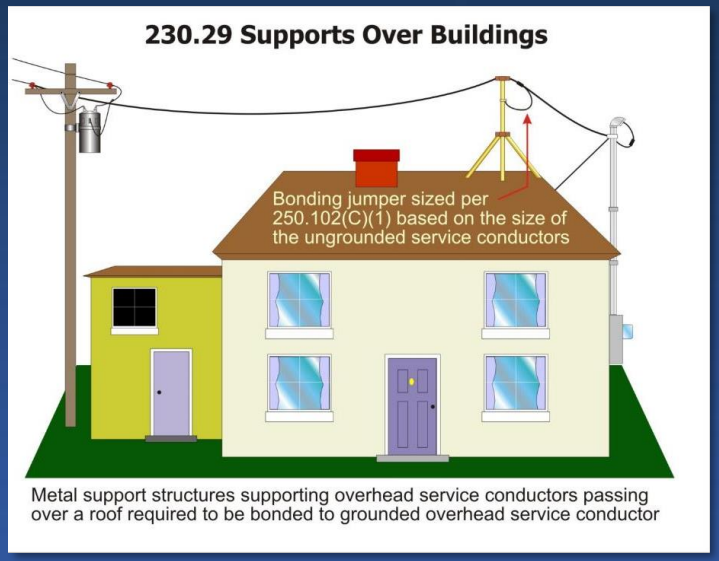
- Overhead conductors
- 230.51 (A) – mounting supports
  - 12" from "ends"
  - 30" intervals
- 230.54 (C)
  - Service heads above point of attachment
  - If impracticable – has to be less than 2 feet
- 230.54 (F)
  - Drip loops – Duke requires 3' minimum
  - Neutral needs to be bare – Duke requirement

Services – Conductor Installation

- 225.17 (A) Mast Support –
- Hubs must be identified for use with service equipment.
- Can't attach conductors to a mast above a coupling if no support above it (floating coupling)
- Same in section 230 (services)

230.29 OVERHEAD SERVICE CONDUCTORS—SUPPORTS OVER BUILDINGS

230.29 Supports over Buildings. Service conductors passing over a roof shall be securely supported by substantial structures. For a grounded system, where the substantial structure is metal, it shall be bonded by means of a bonding jumper and listed connector to the grounded overhead service conductor. Where practicable, such supports shall be independent of the building.



Service – size & metering

- 230.79 (C) – 100 amp for one family dwelling
- 230.79 (D) – 60 amp – others

- Meter must be placed outside unless approved by Duke
- Meter height 4 ½’ – 5 ½’ to center - Duke

Table 310.15(B)(6) Conductor Types and Sizes for 120/240-Volt, 3-Wire, Single-Phase Dwelling Services and Feeders. Conductor Types RHH, RHW, RHW-2, THHN, THHW, THW, THW-2, THWN, THWN-2, XHHW, XHHW-2, SE, USE, USE-2

Conductor (AWG or kcmil)		
Copper	Aluminum or Copper-Clad Aluminum	Service or Feeder Rating (Amperes)
4	2	100
3	1	110
2	1/0	125
1	2/0	150
1/0	3/0	175
2/0	4/0	200
3/0	250	225
4/0	300	250
250	350	300
350	500	350
400	600	400

310.15(B)(7) DWELLING UNIT SERVICES AND FEEDERS

- After many cycles of debate, the provisions for sizing dwelling unit service (and main power feeder) was expanded to allow for 208Y/120-volt single-phase systems.
- Keep in mind this is only for the single-phase component of a three phase 208/120 volt system.
- Many users liked the simplified residential dwelling ampacity table and this was added back to the Annex D7. (Previous Table 310.15(B)(7) in 2014).
- Explanatory language added to address the permitted application of correction or adjustment factors required by 310.15(B)(2)(a) (Temperature Correction Factors) or 310.15(B)(3)(a) (More Than Three Current-Carrying Conductors) applied to the ampacity associated with the temperature rating of the conductors
- New informational note added with direction to 240.6(A) for service ratings based on standard ampacity ratings for application of 310.15(B)(7)

310.15(B)(7)

(7) ~~120/240-Volt,~~ Single-Phase Dwelling Services and Feeders.

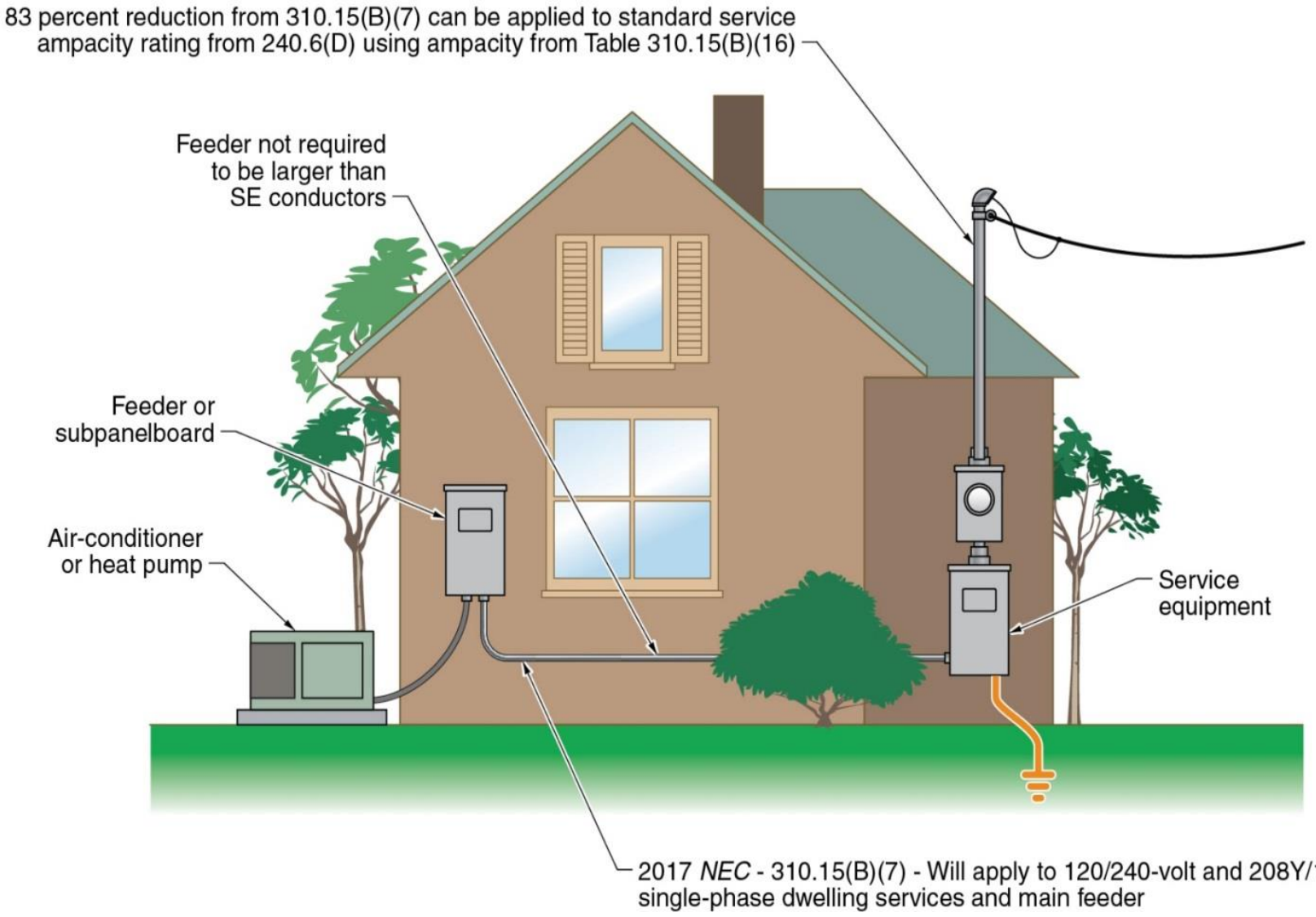
For one-family dwellings and the individual dwelling units of two-family and multifamily dwellings, service and feeder conductors supplied by a single-phase, 120/240-volt system shall be permitted to be sized in accordance with 310.15(B)(7)(1) through (4).

Single-phase feeders from a 208Y/120 volt system shall be permitted to use 310.15(B)(7)(1) through (4).

For a service rated 100 through 400 ~~A~~ amperes, the service conductors supplying the entire load associated with a one-family dwelling, or the service conductors supplying the entire load associated with an individual dwelling unit in a two-family or multifamily dwelling, shall be permitted to have an ampacity not less than 83 percent of the service rating…

Continued on next slide

310.15(B)(7) Dwelling Unit Services and Feeders



Services – Disconnecting Means

- 230.70 (1) – Readily accessible location
  - Nearest point of entrance
  - No six foot rule
    - Service conductor protection
      - Not necessarily panel
  - Don't put in:
  - Bathrooms
  - 240.24(F)
    - Vicinity of easily ignitable material – clothes closets
    - Located above steps

Services – Disconnecting Means

- 230.70 (1) – Readily accessible location
  - Working clearance
    - 3 feet depth – 120/240 volt – 110.26
    - Equipment may not extend 6" beyond the front
      - Be careful of trough
      - Meters are exempt
    - Width – panel width or 30"
      - Can infringe upon other panel space
    - Headroom – 6'6" or ceiling (whichever is greater)
      - Existing dwellings (service changes) exempt from 6'6" if panel is 200 amps or less
    - Door opens 90 degrees


SIEMENS

408.3(A)(2) BARRIERS AT SERVICE PANELBOARDS

- New requirement to provide barrier in all service panelboards such that no uninsulated, ungrounded service busbar or service terminal be exposed to inadvertent contact by persons
- Helps with arc-flash concern and lowers incident energy if energized work performed on load side of main.
- Requirement came from Canadian Electrical Code.
- An exception was also added eliminating the barriers at panelboards installed to comply with the requirements of 408.36, Ex. No. 1, 2, and 3
- Exceptions to 408.36 address the “six means of disconnect” rules and the old “split-bus” panelboards that could be present

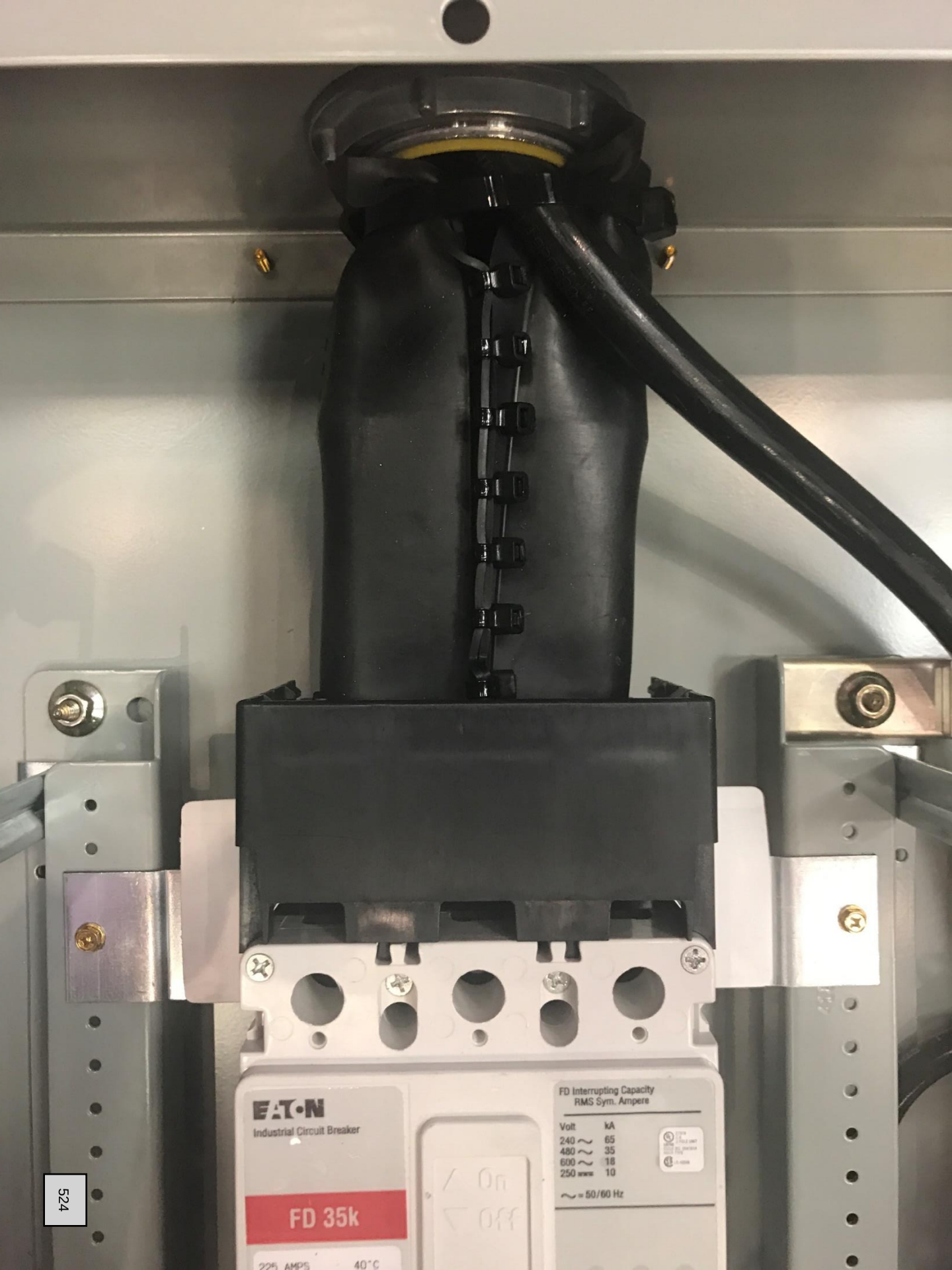
408.3(A)(2) BARRIERS AT SERVICE PANELBOARDS

Barriers required in all service panelboards, switchboards, and switchgear such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

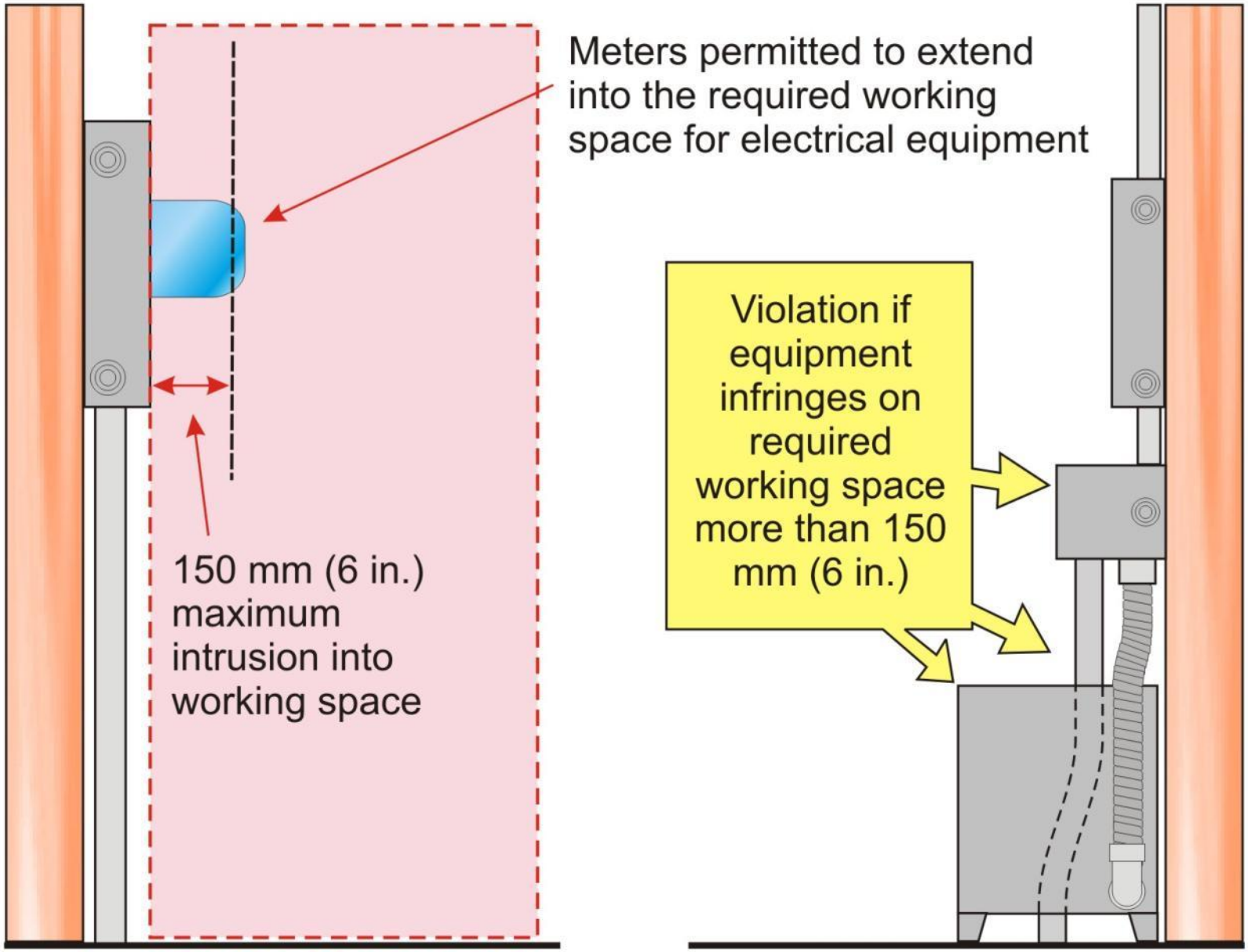
Schneider Electric

Exception: *This requirement shall not apply to service panelboards with provisions for more than one service disconnect within a single enclosure as permitted in 408.36, Exceptions No. 1, 2, and 3*


CAUTION


EATON
Industrial Circuit Breaker
FD 35k
225 AMPS
40°C
FD Interrupting Capacity
RMS Sym. Ampere
Volt
kA
240 ~ 65
480 ~ 35
600 ~ 18
250 ⎓ 10
~ = 50/60 Hz
On
Off

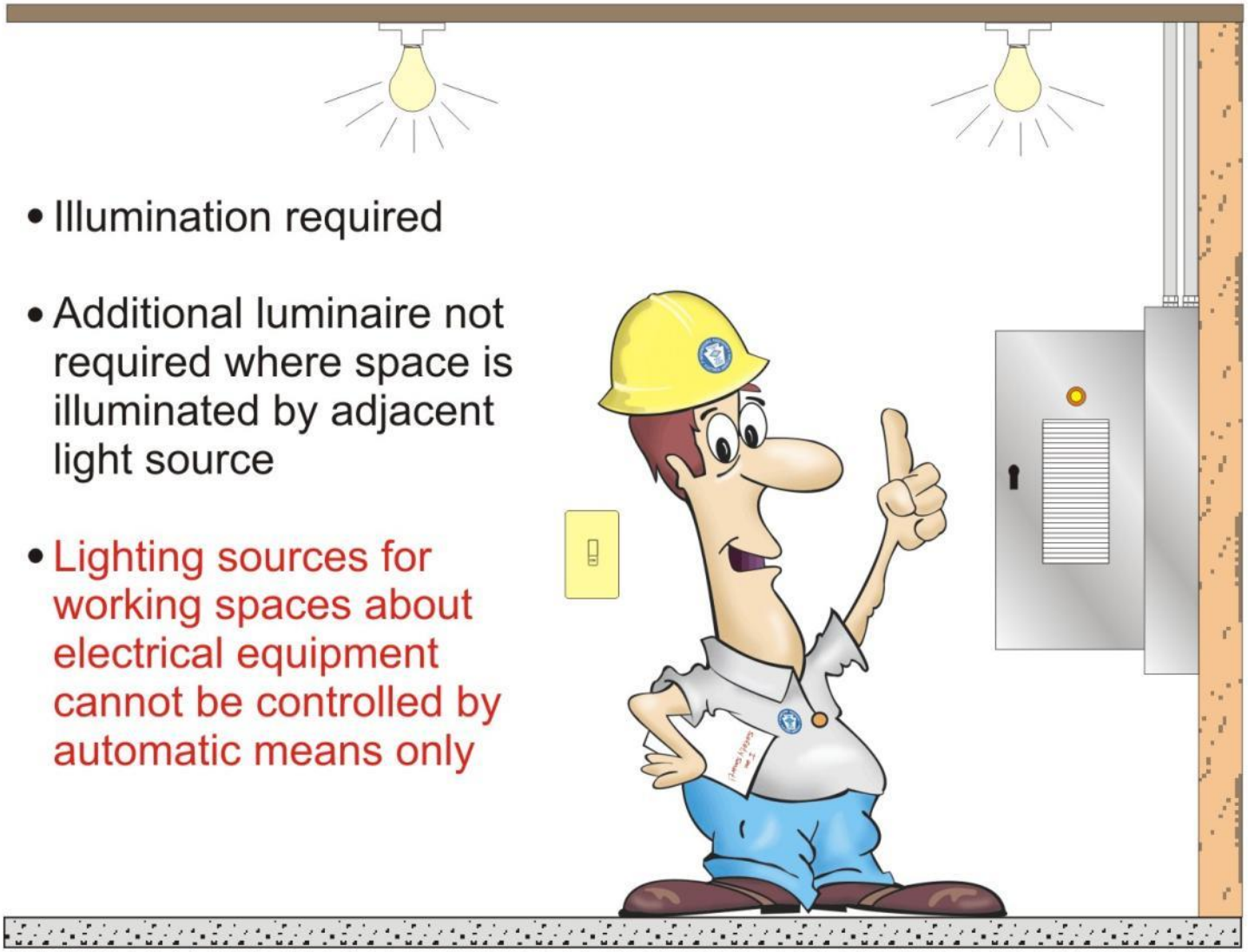
110.26(A)(3), Ex. No. 2 Height of Working Space



Services – Disconnecting Means

- 230.70 (1) – Readily accessible location
  - Illumination – must be lit
  - No automatic devices unless able to be overridden
  - Dedicated equipment space
    - 6 feet above equipment
    - Also applies outdoors
    - Up – On, Down – Off – 404.7

110.26(D) Illumination About Electrical Equipment



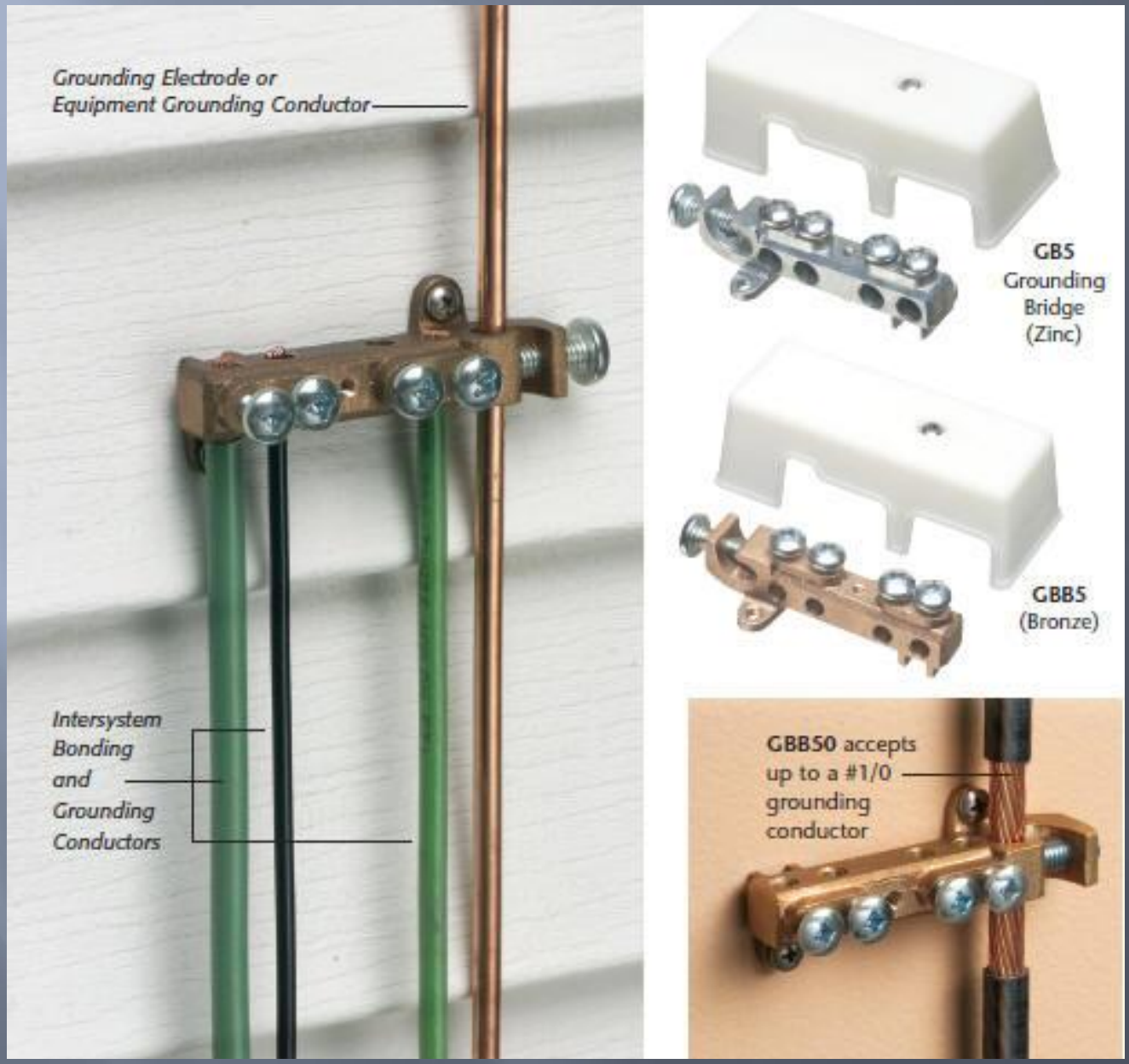
- Illumination required
- Additional luminaire not required where space is illuminated by adjacent light source
- Lighting sources for working spaces about electrical equipment cannot be controlled by automatic means only

Illumination shall be provided for all working spaces about service equipment, switchboards, panelboards, or motor control centers installed indoors

Service – Panel

- 230.71
  - Six switch rule
  - Intersystem bonding
  - Marking of circuits – not arbitrary
  - Handle ties required on shared neutral
    - Red and black conductor in cable must have common trip.
  - Tie wrap neutral with circuit conductors
    - Not needed if you can tell in panel
      - same cable, distinct size, etc.


KOHLER
POWER SYSTEMS


Grounding Electrode or
Equipment Grounding Conductor
Intersystem
Bonding
and
Grounding
Conductors
GB5
Grounding
Bridge
(Zinc)
GBB5
(Bronze)
GBB50 accepts
up to a #1/0
grounding
conductor

ON
20A
OFF
15A
OFF
15A


Percent of Values in Tables 310.16 through 310.19 as Adjusted for Ambient Temperature if Necessary
80
70
50
45
40
35
See Annex B, Table B.310.11, for adjustment factors for more than three current-carrying conductors in a raceway or cable with load diversity.
Multiple Circuits. Where a single equipment grounding conductor is run with multiple circuits in the same raceway, cable, or cable tray, it shall be sized for the largest overcurrent device protecting conductors in the raceway, cable, or cable tray. Equipment grounding conductors installed in cable trays shall meet the minimum requirements

Grounding – 250.52

- Metal Frames of buildings
- Concrete Encased Electrodes - footer
  - 20 feet / #4
  - Listed connector
- Rod and Pipe
  - Supplemental - #6
  - You probably don't need it.
    - Only if metal underground water pipe
    - Only if no other means available
- Other Local metal underground systems
- **Do not ground metal underground gas piping systems**

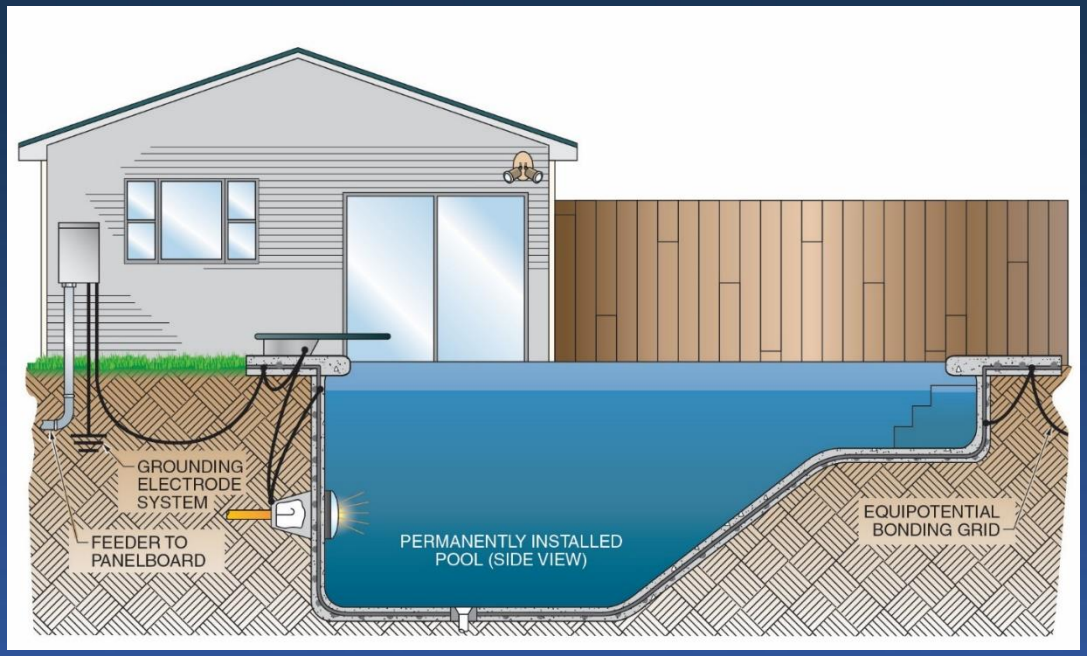
250.52(B)(3) SWIMMING POOLS NOT PERMITTED FOR USE AS GROUNDING ELECTRODES

- Third item added to the list of objects that are prohibited from being used as a grounding electrode at 250.52(B) (cont.)
- Items that shall not be used as a grounding electrode include:
  - Underground gas piping systems
  - An aluminum electrode
  - Structures and structural reinforcing steel of an in-ground swimming pool

250.52(B)(3) SWIMMING POOLS NOT PERMITTED FOR USE AS GROUNDING ELECTRODES

The provisions of 680.26 for equipotential bonding are to reduce voltage gradients *(difference of voltage potential between two conducting objects),* not to establish a grounding electrode system for a building or structure

The structures and structural reinforcing steel of an in-ground swimming pool as described in 680.26(B)(1) and (B)(2) are prohibited from being used as a grounding electrode



Grounding - sizing

- 250.66
- Grounding electrode conductor (water pipe)
  - Contact with earth for at least 10 feet
  - Hit within 5 feet of entrance
  - Jump the meter
- Based on largest ungrounded conductor, not ampacity
- Typical – if pulling normal conductors
- 100 amp - #2 Al conductor - #8 Cu ground
- 150 amp – 2/0 Al conductor - #6 Cu ground
- 200 amp – 4/0 Al conductor - #4 Cu ground

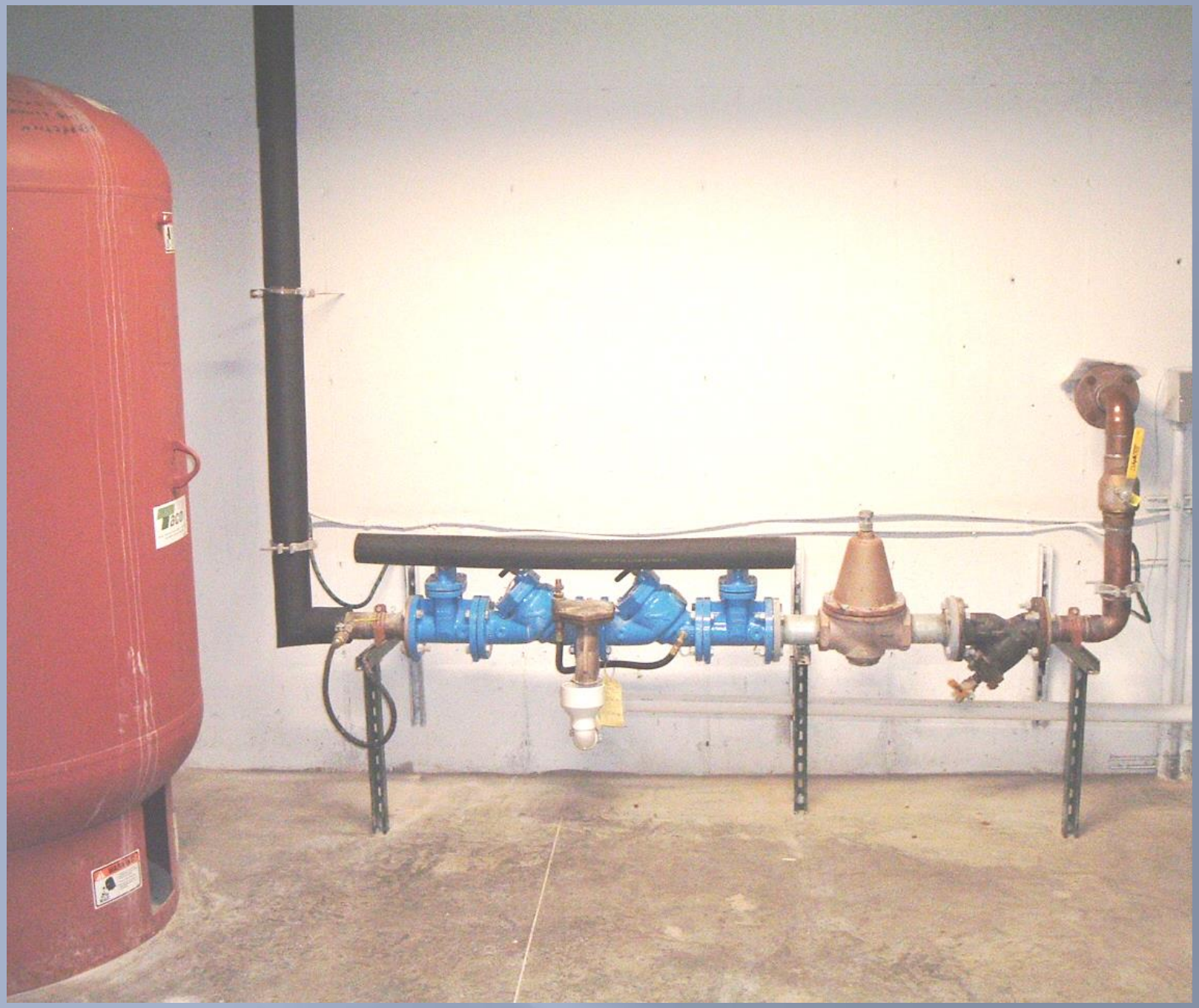


Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors[a] (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum[b]
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Notes:
1. Where multiple sets of service-entrance conductors are used as permitted in 230.40, Exception No. 2, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.
2. Where there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.
[a]This table also applies to the derived conductors of separately derived ac systems.
[b]See installation restrictions in 250.64(A).

(A) Connections to Rod, Pipe, or Plate Electrodes. Where the grounding electrode conductor is connected to rod, pipe, or plate electrodes as permitted in 250.52(A)(5) or (A)(6), that portion of the conductor that is the sole connection to the grounding electrode shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.

(B) Connections to Concrete-Encased Electrodes. Where the grounding electrode conductor is connected to a concrete-encased electrode as permitted in 250.52(A)(3), that portion of the conductor that is the sole connection to the grounding electrode shall not be required to be larger than 4 AWG copper wire.

(C) Connections to Ground Rings. Where the grounding electrode conductor is connected to a ground ring as permitted in 250.52(A)(4), that portion of the conductor that is the sole connection to the grounding electrode shall not be required to be larger than the conductor used for the ground ring.

Cables - Underground

- 300.5 Underground Installations
  - (B) Wet locations – Contains Letter W
  - (C) Under a building – raceway

  If conduit enters building from outside, it must be sealed

- Can't run Romex in conduit to enclosure
  - Sleeve OK
  - Must have a connector

TABLE 300.5 MINIMUM COVER REQUIREMENTS

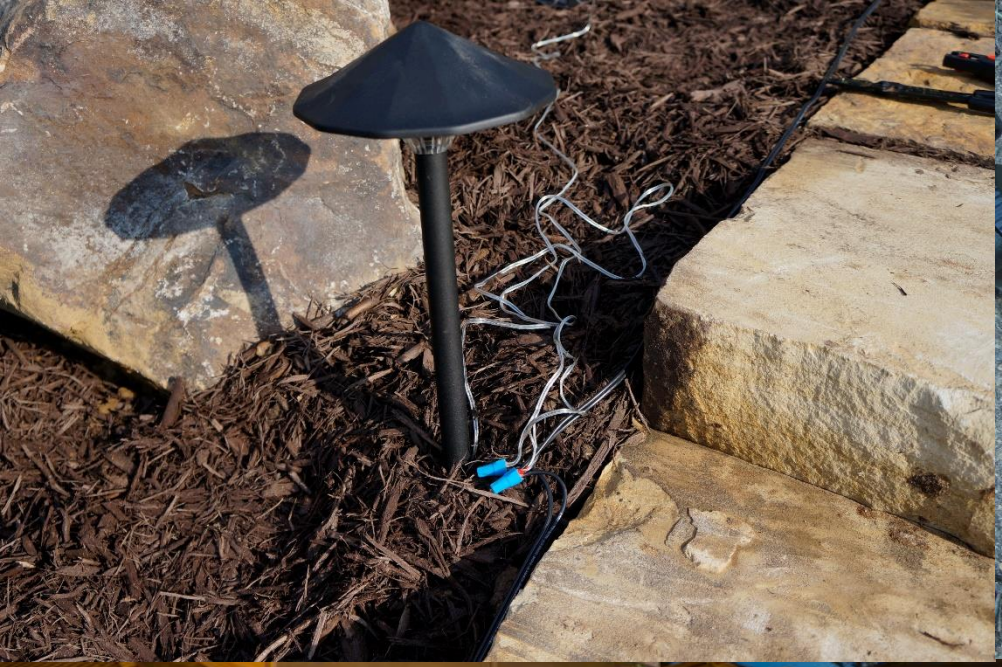
- Low voltage lighting is at voltage levels at 50 volts or below which is less a safety hazard.
- Conflicts is resolved between manufacture instructions that in many cases allows for a reduced wiring depth on the secondary of a transformer than what is required in Table 300.5.
- Added new footnotes to Table 300.5 allowing reduced depths for listed low-voltage lighting system and for pool and spa lighting when included as part of a listed low-voltage lighting system.

Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts, Nominal, Burial in Millimeters (Inches)

Location of Wiring Method or Circuit	Type of Wiring Method or Circuit									
	Column 1 Direct Burial Cables or Conductors		Column 2 Rigid Metal Conduit or Intermediate Metal Conduit		Column 3 Nonmetallic Raceways Listed for Direct Burial Without Concrete Encasement or Other Approved Raceways		Column 4 Residential Branch Circuits Rated 120 Volts or Less with GFCI Protection and Maximum Overcurrent Protection of 20 Amperes		Column 5 Circuits for Control of Irrigation and Landscape Lighting Limited to Not More than 30 volts and Installed with Type UF or in Other Identified Cable or Raceway	
	mm	in	mm	in	mm	in	mm	in	mm	in
All locations not specified below	600	24	150	6	450	18	300	12	150[a, b]	6[a, b]
In trench below 50 mm (2 in.) thick concrete or equivalent	150	18	150	6	300	12	150	6	150	6
Under a building	0	0	0	0	0	0	0	0	0	0
Under minimum of 102 mm (4 in) thick concrete exterior slab with no vehicular traffic and the slab extending not less than 152 mm (6 in) beyond the underground installation.	450	18	100	4	100	4	150 100	6 4	150 100	6 4
Under streets, highways, roads, alleys, driveways, and parking lots	600	24	600	24	600	24	600	24	600	24
One- and two-family dwelling driveways and outdoor parking areas, and used only for dwelling related purposes	450	18	450	18	450	18	300	12	450	18
In or under airport runways, including adjacent areas where trespassing prohibited	450	18	450	18	450	18	300	12	450	18

[a]A lesser depth shall be permitted where specifed in the installation instructions of a listed low-voltage lighting system.

[b]A depth of 150 mm (6 in.) shall be permitted for pool, spa, and fountain lighting, installed in a nonmetallic raceway, limited to not more than 30 volts where part of a listed low-voltage lighting system.



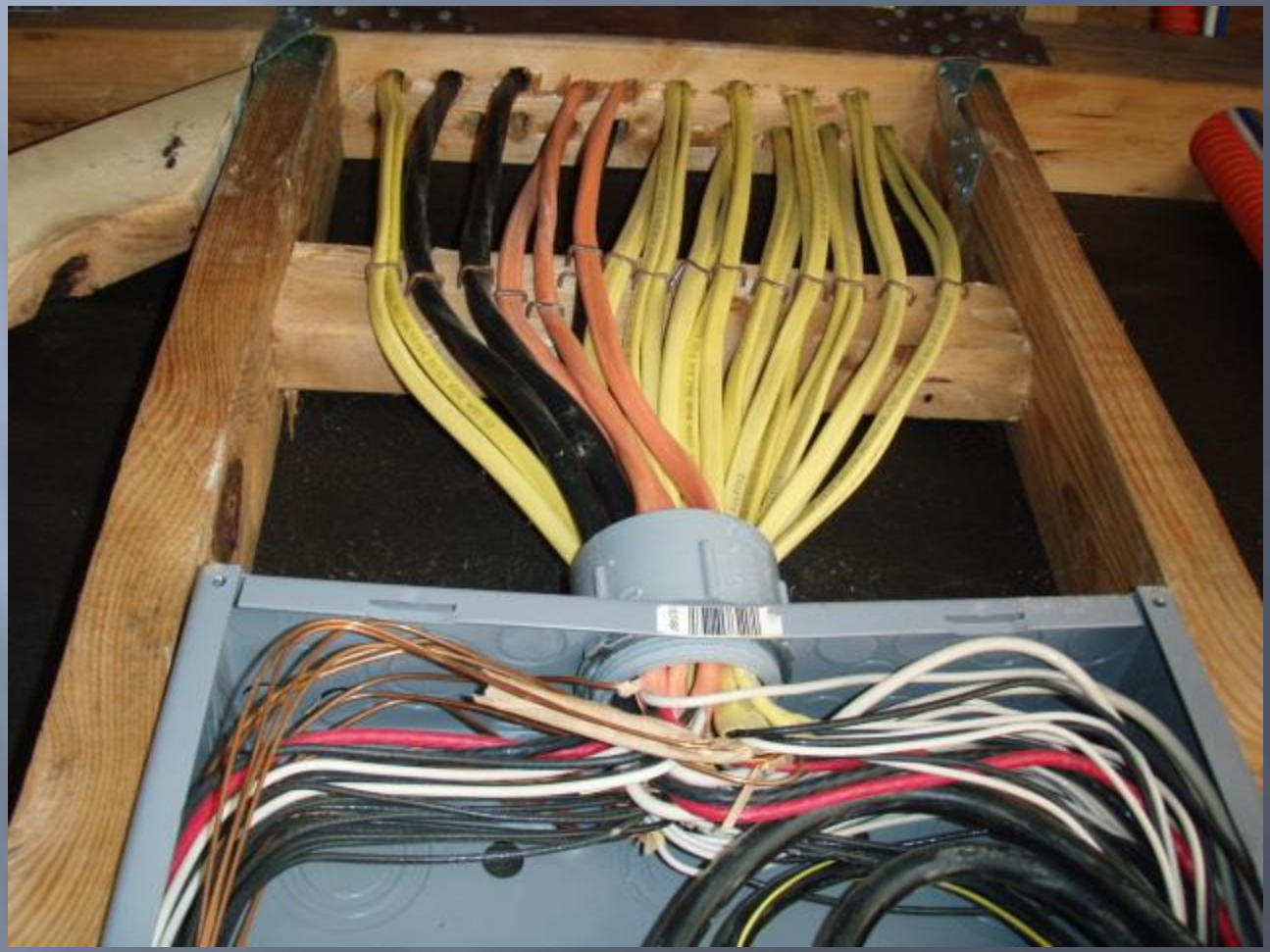
Cables - General

300.4 – Bored Holes
1 ¼" from edge
1/16" protector plate – also notched studs

300.4 – NM through metal framing members
must have grommets completely around

300.22 (B) – Plenums

Bundles of cables run through holes
derating



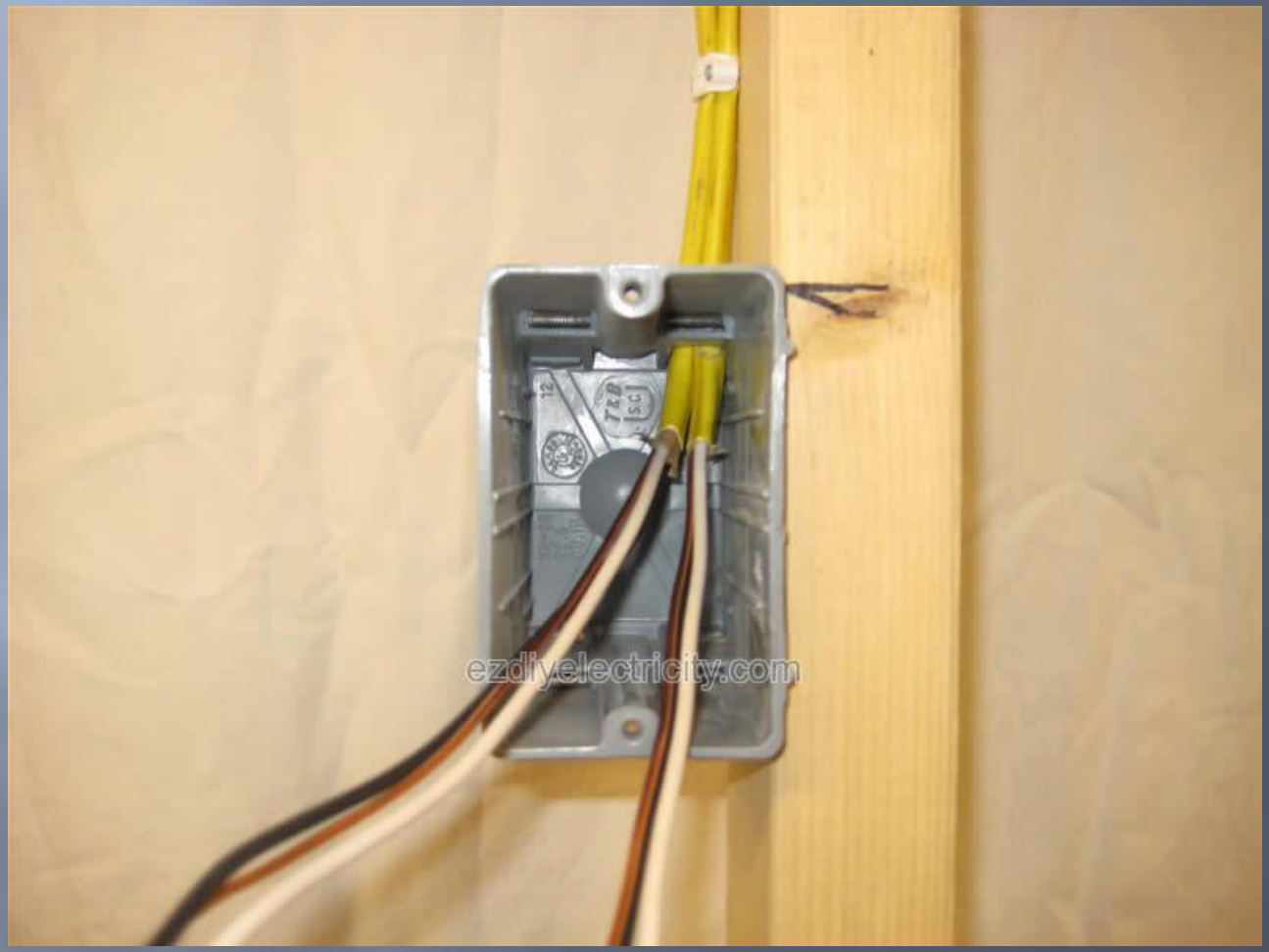
NM Cable

- 334.12 (B)(4) Uses not permitted
  - Wet or damp locations
  - Allowed to use in garages (attached and detached), accessory and storage buildings
- 334.15 (C) Unfinished basements under joists
  - Two - #6 AWG
  - Three - #8 AWG
  - Running boards or bored holes
- 334.30 Securing and supporting
  - 12" / 4 ½'


NOT FOR PRESSURE

NM Cable Support

- 334.30 (A)
  - Horizontal Runs through Holes and Notches
- 314.17 (C) Nonmetallic boxes
  - ¼" sheath in box
  - 8" if cable not supported by box
- Unsupported Cables
  - Fishing
  - 4 ½' for fixture within an accessible ceiling


ezdiyelectricity.com

Boxes - general

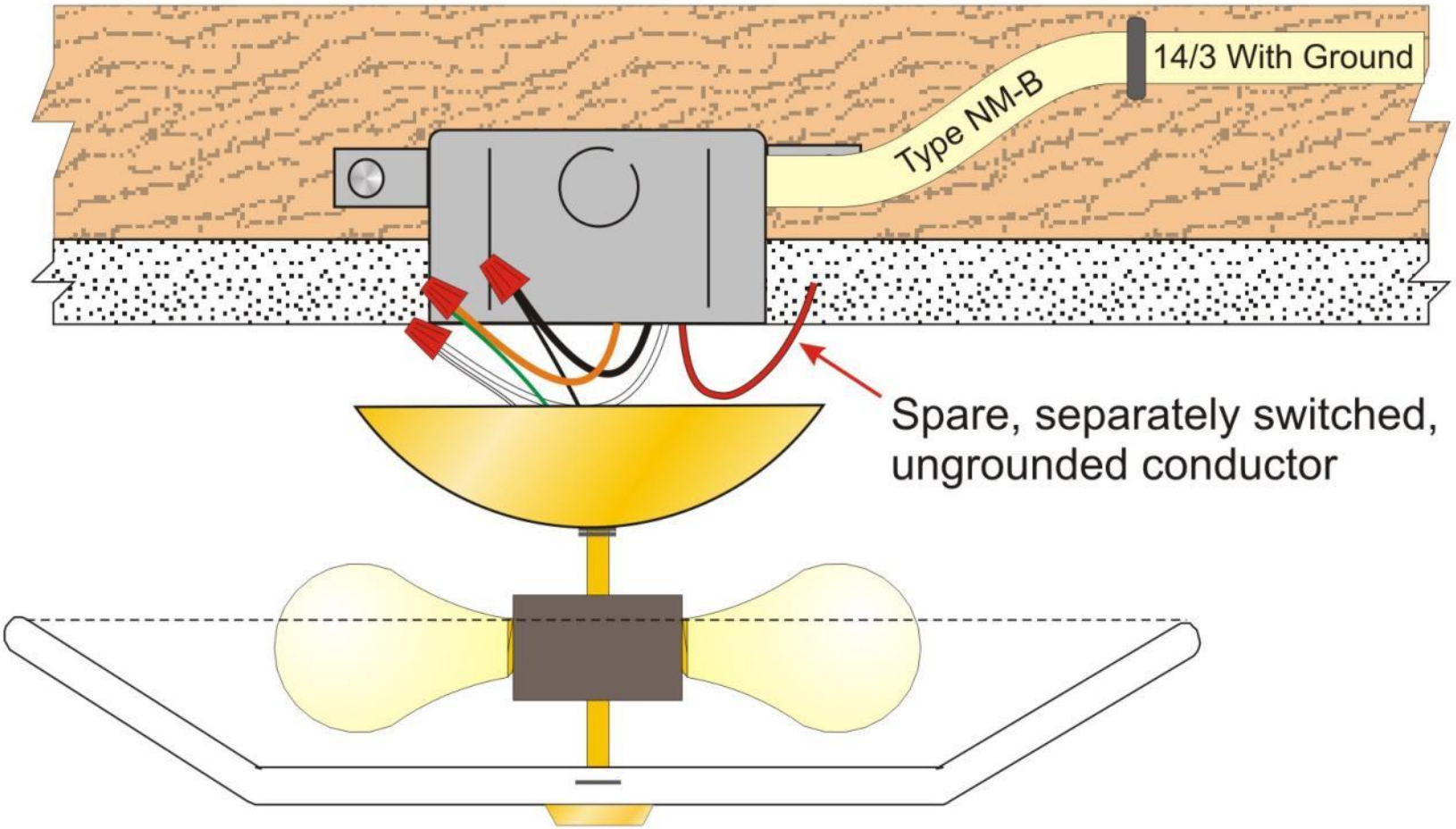
- Boxes must have backs for electrical
- Not needed but allowed for data
- Divider for double gang box
- Close all unused openings
- All boxes must have covers and be accessible
  - Doorbell transformers in basements
- Weatherproof boxes/bell boxes
  - Wet and damp locations

Boxes - fixtures

- Ceiling fan boxes must be listed
  - 70 lbs max
  - Must show max weight if above 35 lbs
  - Weight stamped inside of box - 2014
  - If running 3 wire to ceiling box it must be rated for a fan – if a fan is possible
- Vertical surface outlets (wall sconce)
  - 6 lbs. or less– can use device box
  - Not allowed for ceiling mount

314.27(C) Boxes at Ceiling Fan Outlets

At single or multi-family dwellings, spare, separately switched, ungrounded conductors at ceiling-mounted outlet boxes (in a location acceptable for a ceiling fan) require outlet box or system listed for sole support of a ceiling-suspended (paddle) fan



Circuits required

- Small appliance circuit – 20 amp
  - 2 for counters, can also hit dining room
  - No other receptacles
    - Not more than one kitchen is allowed
    - Definition of a kitchen
- Laundry circuit – 20 amp
  - Typically washing machine
- Bathroom circuit – 20 amp
  - All bath receptacles OR
  - All circuits in ONE bathroom
  - NOT BOTH

Circuits required

- Lighting and general purpose receptacles
  - All lighting
  - Bedroom receptacles
  - Living room/rec room/etc. receptacles
  - Hallway
  - Outdoor
  - Garage

210.11(C)(4) GARAGE BRANCH CIRCUITS

N **(4) Garage Branch Circuits.** In addition to the number of branch circuits required by other parts of this section, at least one 120-volt, 20-ampere branch circuit shall be installed to supply receptacle outlets in attached garages an in detached garages with electric power. This circuit shall have no other outlets.

Exception: This circuit shall be permitted to supply readily accessible outdoor receptacle outlets.

Circuits required

- Take square footage of house
  - Measure on the outside
  - Do not include
    - Garages
    - Open porches/decks
    - Space not adaptable for future use /crawl spaces
- Multiply by 3 (VA)
- Divide by 120 (your voltage)
- Divide by breaker size (typically 15)

Circuits required

- 2,200 square foot house with 400 square foot room addition, 600 square foot garage.
- Total of 2,600 square feet (no garage)
- 2,600 x 3 = 7,800 VA
- You need 7,800 total volt amps of lighting, general receptacles
- 7,800 VA/120 V = 65 amps
- 65 amps/15 amp breakers = 4.3
- You would have to have AT LEAST 5 – 15amp breakers for lighting, general recepts. Etc.

Circuits required

- How many general purpose receptacles are you allowed to put on a 15 amp circuit?

Circuits required

- How many general purpose receptacles are you allowed to put on a 15 amp circuit?

No Limit

File Attachments for Item:

EC-6 Grounding and Bonding (Independent Electrical Contractors)

EPE, ESI, RBO (4 hours)

Grounding

Purpose of Grounding
Grounding Terminology

Different Types of grounding electrodes
- Steel
- Water Pipe
- Ground Rod
- Concrete Encased Electrodes
- Ground Ring
- Ground Plates

Sizing the grounding electrode – 250.66

Sizing the Main bonding jumper – 250.102(C)(1)
- 12 ½% rule

Sizing the equipment ground – 250.122
- Sizing the equipment ground conductor when oversizing the phase conductors.

Bonding requirements – Both on line side and load side.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Kevin Collins (Contact Name)
Organization: IEC of Greater Cincinnati (Organization/Company)
Address: 586 Kings Run Drive (Include Room Number, Suite, etc.)
City: Cincinnati State: OH Zip: 45232
E-Mail: KCollins@iec-cincy.com
Telephone: 513-542-0400 Fax: —
Course Sponsor: IEC of Greater Cincinnati

COURSE INFORMATION:

Course Title: Grounding + Bonding

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: Review article 250 of the NEC. We will discuss different grounding electrodes, what are required at different structures, sizing the GEC, different types of equipment grounding conductors, how to size them, where main bonding jumpers / system bonding jumpers are required + how to size them

Number of Instructional Contact Hours that can be obtained upon completion: 4

If Multi-Session, Number of Instructional Contact Hours Per Session: —

Program Applicable for the Following Participants:

Building Official ☐ Master Plans Examiner ☐ Plumbing Plans Exam. ☐ Electrical Plans Exam. ☒ Mechanical Plans Exam. ☐ Building Inspector ☐ Fire Protection Inspector ☐ Mechanical Inspector ☐ Plumbing Inspector ☐ Non-Res IU Inspector ☐

Res Building Official ☒ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☒
Location of ESI Course: IEC of Greater Cincinnati Date(s) of ESI Course(s): 3/15/23

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
Course Sponsor:	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:	Copy of quizzes or tests to be given	
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Sean Clark

901 Beechmeadow Ln. Cincinnati, Ohio 45238
(H)513/347-9054 (C)513/800-4450
sclark@ohiovalleyelectric.com

••••••••••••••••••••••••••••

A licensed electrician with over twenty years of experience in installing, maintaining, and repairing electrical wiring, equipment, and fixtures, ensuring that work is in accordance with relevant codes, fire alarm installations, electrical control systems, and high voltage terminations. A licensed electrician with three years teaching experience in first and second year electrical.

Summary of Qualifications

- More than twenty years experience.
- Three years experience in teaching first and second year electrical.
- Thorough knowledge of electrical systems including planning additions and modifications on secondary circuits. Controls and low voltage wiring
- Able to read commercial electrical blueprints and apply NEC through the full range of commercial and industrial maintenance and construction work.
- Can use appropriate tools and diagnostic equipment to repair, install, replace, and test electrical circuits, equipment and appliances.
- Excellent ability to diagnose and repair electrical controls, industrial motor control centers, and programmable logic controllers.
- Strong desire to study and comprehend new technology.
- In-depth ability to make mathematical computations.
- Considerable ability to explain instructions and guidelines to others effectively.
- Able to assign work to employees., prioritize the work of others and organize and coordinate the work of the unit. For subs and Primes.

Professional Experience

Ohio Valley Electrical Services 2011-Present

ABC Electrical Teacher 2010-2013

Beacon Electrical Contractors 2007-2011

Ohio Valley Electrical Services 1993-2007

Electrical Superintendant/Foreman/Instructor

- First and Second year electrical instructor
- Supervision of all electrical installations of as many as 50 electricians to assure that work was done safely, efficiently, properly and within time allowed.
- Trained multiple employees in all aspects of electrical work to be able to identify an employee's strengths and weaknesses to better utilize their skills. Traced out short circuits in wiring, using test meter.
- Coordinated and implemented electrical projects within a variety of environments including plants, hospitals, schools, retail stores, public facilities, waste water treatment plants industrial buildings;

projects include both new construction and underground electrical wiring as well as renovation within existing buildings. Parking Garages and Fed Ex Ground Facilities.

- Assemble, install, test, and maintain electrical or electronic wiring, equipment, appliances, apparatus, and fixtures, using hand tools and power tools.
- Connect wires to circuit breakers, transformers, or other components.
- Construct and fabricate parts, using hand tools and specifications.
- Diagnose malfunctioning systems, apparatus, and components, using test equipment and hand tools, to locate the cause of a breakdown and correct the problem.
- Inspect electrical systems, equipment, and components to identify hazards, defects, and the need for adjustment or repair, and to ensure compliance with codes.
- Plan layout and installation of electrical wiring, equipment and fixtures, based on job specifications and local codes.
- Test electrical systems and continuity of circuits in electrical wiring, equipment, and fixtures, using testing devices such as ohmmeters, voltmeters, and oscilloscopes, to ensure compatibility and safety of system.
- Perform business management duties such as maintaining records and files, preparing reports and ordering supplies and equipment.

Education & Certifications

Master Electrician License-State of Kentucky

Journeyman Electrician's License-Hamilton, Ohio

Fire Alarm License-State of Ohio

Certified in high voltage terminations and splices

Lift, Lull, Bobcat, and Boom/scissors lift licenses

OSHA-30 card

Certified in first aid and CPR training

Certified NCCER Core Curricula Instructor

Certified NCCER Electrical Instructor

Completed 4 year apprenticeship program

1 Year Pre-apprentice school (ABC)

High School Diploma (1991)

ARCH FLASH SAFETY TRAINING

PROJECTS-SUPERVISED

$4.5mil.-MASON HIGH SCHOOL ADDITION

$250.000-3CDC-5TH RACE PARKING GARAGE

$250.000-AVONEDALE APT. COMPLEX

$100.000-MAHOGANYS AT THE BANK-

1.2mil. -PATHEON CHEMICALS

$450.000- FED EX GROUND ADDITION

$250.000-LIBERTY WAY PROJECT

$500.000-GE AT THE BANKS

$100.000 - SYCAMORE SCHOOLS/POWER/CONTROL-

$50.000 - NKU RETROFIT

$250.000- UC POWER PLANT ADDITION

$75.000 - 580BLD/ CHEMED, RETROFIT

$4.0mil - DHL- CONVEYERS/SHELL

$90.000- DOUBLE TREE AIRPORT

$2.5mil- TWIN LAKES OF MONTGOMERY

$45.000- STEINMART ANDERSON

And many small T&M jobs.

All on time and under budget

Grounding Article 250

Grounding

- 250.66
- 250.102(C)(1)
- 250.122

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors[a] (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum[b]
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Table 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper* (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:

1. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.

Table 250.122 Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum*
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	750
5000	700	1200
6000	800	1200

Note: Where necessary to comply with 250.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.

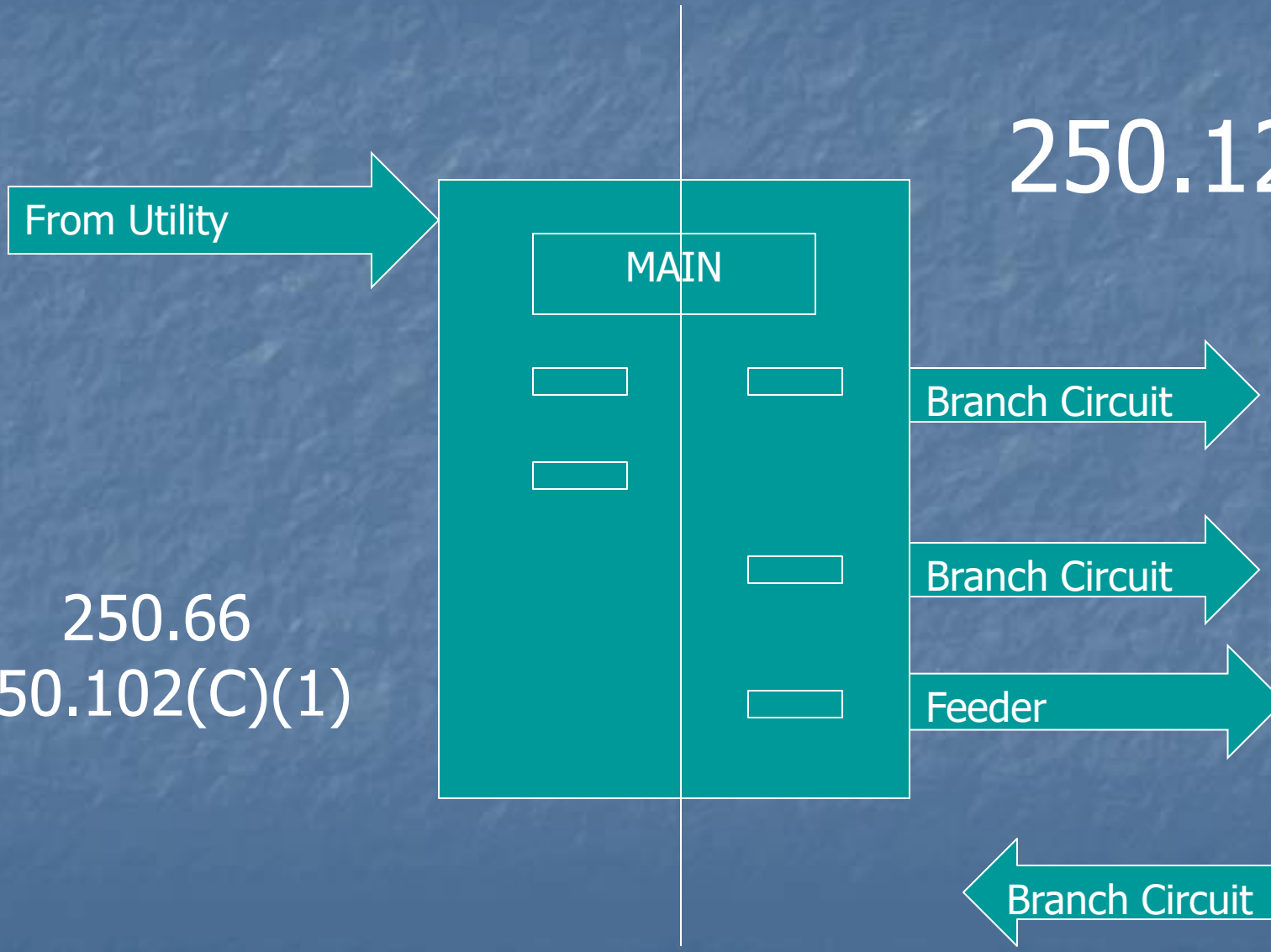
*See installation restrictions in 250.120.

Grounding

- 250.66/250.102(C)(1) vs. 250.122
  - .66 & 102(C)(1) is before first overcurrent protection device. (SERVICE)
  - .122 based on the size of overcurrent protection device in circuit

Grounding

250.122



250.66
250.102(C)(1)

Grounding electrode(s)

- Based on 250.66
- Water pipe, steel, ground rod, footer ground (concrete encased electrode), ground ring, ground plate are all grounding electrodes. All are sized off this chart.
  - Additional code articles to NOT require grounding electrode conductor to:
    - Ground rod conductor larger than 6 – 250.66 (A)
    - Concrete encased (footer) larger than 4 – 250.66 (B)
    - Ground ring larger than 2 – 250.66 (C)

Grounding electrode(s)

- Based on 250.66
- Grounding electrode conductors MAX OUT
  - 3/0 Cu or 250 Al is the largest required

- Based on size of TOTAL area of ONE phase
    - Add all of the conductors of the same phase (hots)
  - Has nothing to do with service size
  - Make sure to read chart carefully
    - 3/0, 350, 600 and 1100 appear twice
      - One row will say through
      - One row will say over

Grounding

- Example
  - I have 1 set of 3/0 Cu feeding a 200 amp service. Size the grounding electrode to the metal in-ground support structure (steel), water pipe, ground rod and the concrete encased electrode:

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors[a] (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum[b]
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Grounding

- Example
  - I have 1 set of 3/0 Cu feeding a 200 amp service. Size the grounding electrode to the metal in-ground support structure (steel), water pipe, ground rod and the concrete encased electrode
  - Find 3/0 on 250.66 – read across
  - Water pipe - **#4 Cu or #2 Al**
  - Steel - **#4 Cu or #2 Al**
  - Ground rod **#6**, Concrete encased **#4**

MAKE SURE TO ANSWER IN CORRECT CONDUCTOR TYPE

Grounding

- Example (parallel sets)
  - I have 4 sets of 350 kcmil Cu feeding a 1200 amp service. Size the grounding electrode to the metal in-ground support structure, water pipe, ground rod and the concrete encased electrode:

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors[a] (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum[b]
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Grounding

- Example (parallel sets)
  - I have 4 sets of 350 kcmil Cu feeding a 1200 amp service. Size the grounding electrode to the metal in-ground support stucture, water pipe, ground rod and the concrete encased electrode
  - 4 x 350,000 = 1,400,000 or 1,400 kcmil
  - 1,400 kcmil exceeds 250.66
  - Water pipe – **3/0 Cu or 250 kcmil Al**
  - Steel – **3/0 Cu or 250 kcmil Al**
  - Rod - **#6**, Concrete encased - **#4**

Grounding

- Example
  - I have 2 sets of 250 kcmil Cu feeding a 500 amp service. Size the grounding electrode to the metal in-ground support stucture, water pipe, ground rod and the concrete encased electrode:

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors[a] (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum[b]
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Grounding

- Example
  - I have 2 sets of 250 kcmil Cu feeding a 500 amp service. Size the grounding electrode to the metal in-ground support stucture, water pipe, ground rod and the concrete encased electrode
  - 2 x 250,000 = 500,000 or 500 kcmil
  - Water pipe – **1/0 Cu or 3/0 kcmil Al**
  - Steel – **1/0 Cu or 3/0 kcmil Al**
  - Rod - **#6**, Concrete encased - **#4**

Grounding

- Main bonding jumper (MBJ)
  - New chart – 250.102(C)(1) – almost same as 250.66
  - Bonds the grounded conductor (neutral) to the grounding conductor (ground)
    - Only done once per service
    - Also transformers/treat like a new service
  - Size the same as grounding electrode
    - Only difference is it does not max out
    - Read directly off chart until you are over 1100 kcmil Cu or 250 Al.

  Grounding electrode conductor and MBJ will be the same size unless conductors exceed 250.66.

Table 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper* (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:

1. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.

Grounding - Main Bonding Jumper

- Once the total of a phase exceeds 250.102(C)(1) THEN use 12 ½%
- Take 12 ½% of kcmil and size it from Table 8 in back of code book

DO NOT USE 12 ½% AUTOMATICALLY ON THE MBJ

Table 8 Conductor Properties

Size (AWG or kcmil)	Area		Conductors							Direct-Current Resistance at 75°C (167°F)					
			Stranding			Overall				Copper				Aluminum	
				Diameter		Diameter		Area		Uncoated		Coated			
	mm²	Circular mils	Quantity	mm	in.	mm	in.	mm²	in.²	ohm/km	ohm/kFT	ohm/km	ohm/kFT	ohm/km	ohm/kFT
18	0.823	1620	1	—	—	1.02	0.040	0.823	0.001	25.5	7.77	26.5	8.08	42.0	12.8
18	0.823	1620	7	0.39	0.015	1.16	0.046	1.06	0.002	26.1	7.95	27.7	8.45	42.8	13.1
16	1.31	2580	1	—	—	1.29	0.051	1.31	0.002	16.0	4.89	16.7	5.08	26.4	8.05
16	1.31	2580	7	0.49	0.019	1.46	0.058	1.68	0.003	16.4	4.99	17.3	5.29	26.9	8.21
14	2.08	4110	1	—	—	1.63	0.064	2.08	0.003	10.1	3.07	10.4	3.19	16.6	5.06
14	2.08	4110	7	0.62	0.024	1.85	0.073	2.68	0.004	10.3	3.14	10.7	3.26	16.9	5.17
12	3.31	6530	1	—	—	2.05	0.081	3.31	0.005	6.34	1.93	6.57	2.01	10.45	3.18
12	3.31	6530	7	0.78	0.030	2.32	0.092	4.25	0.006	6.50	1.98	6.73	2.05	10.69	3.25
10	5.261	10380	1	—	—	2.588	0.102	5.26	0.008	3.984	1.21	4.148	1.26	6.561	2.00
10	5.261	10380	7	0.98	0.038	2.95	0.116	6.76	0.011	4.070	1.24	4.226	1.29	6.679	2.04
8	8.367	16510	1	—	—	3.264	0.128	8.37	0.013	2.506	0.764	2.579	0.786	4.125	1.26
8	8.367	16510	7	1.23	0.049	3.71	0.146	10.76	0.017	2.551	0.778	2.653	0.809	4.204	1.28
6	13.30	26240	7	1.56	0.061	4.67	0.184	17.09	0.027	1.608	0.491	1.671	0.510	2.652	0.808
4	21.15	41740	7	1.96	0.077	5.89	0.232	27.19	0.042	1.010	0.308	1.053	0.321	1.666	0.508
3	26.67	52620	7	2.20	0.087	6.60	0.260	34.28	0.053	0.802	0.245	0.833	0.254	1.320	0.403
2	33.62	66360	7	2.47	0.097	7.42	0.292	43.23	0.067	0.634	0.194	0.661	0.201	1.045	0.319
1	42.41	83690	19	1.69	0.066	8.43	0.332	55.80	0.087	0.505	0.154	0.524	0.160	0.829	0.253
1/0	53.49	105600	19	1.89	0.074	9.45	0.372	70.41	0.109	0.399	0.122	0.415	0.127	0.660	0.201
2/0	67.43	133100	19	2.13	0.084	10.62	0.418	88.74	0.137	0.3170	0.0967	0.329	0.101	0.523	0.159
3/0	85.01	167800	19	2.39	0.094	11.94	0.470	111.9	0.173	0.2512	0.0766	0.2610	0.0797	0.413	0.126
4/0	107.2	211600	19	2.68	0.106	13.41	0.528	141.1	0.219	0.1996	0.0608	0.2050	0.0626	0.328	0.100
250	127	—	37	2.09	0.082	14.61	0.575	168	0.260	0.1687	0.0515	0.1753	0.0535	0.2778	0.0847
300	152	—	37	2.29	0.090	16.00	0.630	201	0.312	0.1409	0.0429	0.1463	0.0446	0.2318	0.0707
350	177	—	37	2.47	0.097	17.30	0.681	235	0.364	0.1205	0.0367	0.1252	0.0382	0.1984	0.0605
400	203	—	37	2.64	0.104	18.49	0.728	268	0.416	0.1053	0.0321	0.1084	0.0331	0.1737	0.0529
500	253	—	37	2.95	0.116	20.65	0.813	336	0.519	0.0845	0.0258	0.0869	0.0265	0.1391	0.0424
600	304	—	61	2.52	0.099	22.68	0.893	404	0.626	0.0704	0.0214	0.0732	0.0223	0.1159	0.0353
700	355	—	61	2.72	0.107	24.49	0.964	471	0.730	0.0603	0.0184	0.0622	0.0189	0.0994	0.0303
750	380	—	61	2.82	0.111	25.35	0.998	505	0.782	0.0563	0.0171	0.0579	0.0176	0.0927	0.0282
800	405	—	61	2.91	0.114	26.16	1.030	538	0.834	0.0528	0.0161	0.0544	0.0166	0.0868	0.0265
900	456	—	61	3.09	0.122	27.79	1.094	606	0.940	0.0470	0.0143	0.0481	0.0147	0.0770	0.0235
1000	507	—	61	3.25	0.128	29.26	1.152	673	1.042	0.0423	0.0129	0.0434	0.0132	0.0695	0.0212
1250	633	—	91	2.98	0.117	32.74	1.289	842	1.305	0.0338	0.0103	0.0347	0.0106	0.0554	0.0169
1500	760	—	91	3.26	0.128	35.86	1.412	1011	1.566	0.02814	0.00858	0.02814	0.00883	0.0464	0.0141
1750	887	—	127	2.98	0.117	38.76	1.526	1180	1.829	0.02410	0.00735	0.02410	0.00756	0.0397	0.0121
2000	1013	—	127	3.19	0.126	41.45	1.632	1349	2.092	0.02109	0.00643	0.02109	0.00662	0.0348	0.0106

Notes:

1. These resistance values are valid **only** for the parameters as given. Using conductors having coated strands, different stranding type, and, especially, other temperatures changes the resistance.
2. Equation for temperature change: $R_2 = R_1 [1 + \alpha (T_2 - 75)]$ where $\alpha_{cu} = 0.00323$, $\alpha_{AL} = 0.00330$ at 75°C.

Grounding – Main Bonding Jumper

- Example
  - I have 4 sets of 350MCM Cu feeding a 1200 amp service. Size the Cu main bonding jumper.

Grounding – Main Bonding Jumper

- Example
  - I have 4 sets of 350 kcmil Cu feeding a 1200 amp service. Size the main bonding jumper.
  - 4 x 350,000 = 1,400,000 or 1,400 kcmil
  - 1400 kcmil exceeds chart
  - 1,400,000 x .125 (12 ½%) = 175,000.
  - The main bonding jumper must be AT LEAST 175,000 circular mills

Table 8 Conductor Properties

Size (AWG or kcmil)	Area		Conductors							Direct-Current Resistance at 75°C (167°F)					
			Stranding			Overall				Copper				Aluminum	
				Diameter		Diameter		Area		Uncoated		Coated			
	mm²	Circular mils	Quantity	mm	in.	mm	in.	mm²	in.²	ohm/km	ohm/kFT	ohm/km	ohm/kFT	ohm/km	ohm/kFT
18	0.823	1620	1	—	—	1.02	0.040	0.823	0.001	25.5	7.77	26.5	8.08	42.0	12.8
18	0.823	1620	7	0.39	0.015	1.16	0.046	1.06	0.002	26.1	7.95	27.7	8.45	42.8	13.1
16	1.31	2580	1	—	—	1.29	0.051	1.31	0.002	16.0	4.89	16.7	5.08	26.4	8.05
16	1.31	2580	7	0.49	0.019	1.46	0.058	1.68	0.003	16.4	4.99	17.3	5.29	26.9	8.21
14	2.08	4110	1	—	—	1.63	0.064	2.08	0.003	10.1	3.07	10.4	3.19	16.6	5.06
14	2.08	4110	7	0.62	0.024	1.85	0.073	2.68	0.004	10.3	3.14	10.7	3.26	16.9	5.17
12	3.31	6530	1	—	—	2.05	0.081	3.31	0.005	6.34	1.93	6.57	2.01	10.45	3.18
12	3.31	6530	7	0.78	0.030	2.32	0.092	4.25	0.006	6.50	1.98	6.73	2.05	10.69	3.25
10	5.261	10380	1	—	—	2.588	0.102	5.26	0.008	3.984	1.21	4.148	1.26	6.561	2.00
10	5.261	10380	7	0.98	0.038	2.95	0.116	6.76	0.011	4.070	1.24	4.226	1.29	6.679	2.04
8	8.367	16510	1	—	—	3.264	0.128	8.37	0.013	2.506	0.764	2.579	0.786	4.125	1.26
8	8.367	16510	7	1.23	0.049	3.71	0.146	10.76	0.017	2.551	0.778	2.653	0.809	4.204	1.28
6	13.30	26240	7	1.56	0.061	4.67	0.184	17.09	0.027	1.608	0.491	1.671	0.510	2.652	0.808
4	21.15	41740	7	1.96	0.077	5.89	0.232	27.19	0.042	1.010	0.308	1.053	0.321	1.666	0.508
3	26.67	52620	7	2.20	0.087	6.60	0.260	34.28	0.053	0.802	0.245	0.833	0.254	1.320	0.403
2	33.62	66360	7	2.47	0.097	7.42	0.292	43.23	0.067	0.634	0.194	0.661	0.201	1.045	0.319
1	42.41	83690	19	1.69	0.066	8.43	0.332	55.80	0.087	0.505	0.154	0.524	0.160	0.829	0.253
1/0	53.49	105600	19	1.89	0.074	9.45	0.372	70.41	0.109	0.399	0.122	0.415	0.127	0.660	0.201
2/0	67.43	133100	19	2.13	0.084	10.62	0.418	88.74	0.137	0.3170	0.0967	0.329	0.101	0.523	0.159
3/0	85.01	167800	19	2.39	0.094	11.94	0.470	111.9	0.173	0.2512	0.0766	0.2610	0.0797	0.413	0.126
4/0	107.2	211600	19	2.68	0.106	13.41	0.528	141.1	0.219	0.1996	0.0608	0.2050	0.0626	0.328	0.100
250	127	—	37	2.09	0.082	14.61	0.575	168	0.260	0.1687	0.0515	0.1753	0.0535	0.2778	0.0847
300	152	—	37	2.29	0.090	16.00	0.630	201	0.312	0.1409	0.0429	0.1463	0.0446	0.2318	0.0707
350	177	—	37	2.47	0.097	17.30	0.681	235	0.364	0.1205	0.0367	0.1252	0.0382	0.1984	0.0605
400	203	—	37	2.64	0.104	18.49	0.728	268	0.416	0.1053	0.0321	0.1084	0.0331	0.1737	0.0529
500	253	—	37	2.95	0.116	20.65	0.813	336	0.519	0.0845	0.0258	0.0869	0.0265	0.1391	0.0424
600	304	—	61	2.52	0.099	22.68	0.893	404	0.626	0.0704	0.0214	0.0732	0.0223	0.1159	0.0353
700	355	—	61	2.72	0.107	24.49	0.964	471	0.730	0.0603	0.0184	0.0622	0.0189	0.0994	0.0303
750	380	—	61	2.82	0.111	25.35	0.998	505	0.782	0.0563	0.0171	0.0579	0.0176	0.0927	0.0282
800	405	—	61	2.91	0.114	26.16	1.030	538	0.834	0.0528	0.0161	0.0544	0.0166	0.0868	0.0265
900	456	—	61	3.09	0.122	27.79	1.094	606	0.940	0.0470	0.0143	0.0481	0.0147	0.0770	0.0235
1000	507	—	61	3.25	0.128	29.26	1.152	673	1.042	0.0423	0.0129	0.0434	0.0132	0.0695	0.0212
1250	633	—	91	2.98	0.117	32.74	1.289	842	1.305	0.0338	0.0103	0.0347	0.0106	0.0554	0.0169
1500	760	—	91	3.26	0.128	35.86	1.412	1011	1.566	0.02814	0.00858	0.02814	0.00883	0.0464	0.0141
1750	887	—	127	2.98	0.117	38.76	1.526	1180	1.829	0.02410	0.00735	0.02410	0.00756	0.0397	0.0121
2000	1013	—	127	3.19	0.126	41.45	1.632	1349	2.092	0.02109	0.00643	0.02109	0.00662	0.0348	0.0106

Notes:

1. These resistance values are valid **only** for the parameters as given. Using conductors having coated strands, different stranding type, and, especially, other temperatures changes the resistance.
2. Equation for temperature change: $R_2 = R_1 [1 + \alpha (T_2 - 75)]$ where $\alpha_{cu} = 0.00323$, $\alpha_{AL} = 0.00330$ at 75°C.

Grounding – Main Bonding Jumper

- Refer to Table 8 conductor properties
  - 3/0 is 167,800 circular mills
  - 4/0 is 211,600 circular mills
    - Parallel 4/0 - sizing
- 4/0 Cu is the size of the main bonding jumper.
- You can not round this number up no matter how close it is.
- Conductors 250 kcmil and larger are already labeled in circular mill
  - Ex. If you needed 311,000 kcmil, you would need 350MCM.

Grounding – Main Bonding Jumper

- Example
  - I have 2 sets of 350MCM Cu feeding a 600 amp service. Size the Cu main bonding jumper:

Grounding – Main Bonding Jumper

- Example
  - I have 2 sets of 350 kcmil Cu feeding a 600 amp service. Size the main bonding jumper.
  - 2 x 350,000 = 700,000 or 700 kcmil
  - 700 kcmil does not exceed the chart
- The main bonding jumper is:
  - 2/0 Cu or 4/0 Al

Table 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper* (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:

1. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.

Grounding

- 250.122 – Equipment grounding conductor
  - Based on the size of overcurrent protection device in circuit

Table 250.122 Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum*
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	750
5000	700	1200
6000	800	1200

Note: Where necessary to comply with 250.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.

*See installation restrictions in 250.120.

Grounding

- 250.122
  - Must go up if in between sizes
  - What size Cu is the equipment grounding conductor on a 60 amp circuit?
  - What size Cu is the equipment grounding conductor on a 90 amp circuit?

600

Table 250.122 Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum*
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	750
5000	700	1200
6000	800	1200

Note: Where necessary to comply with 250.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.

*See installation restrictions in 250.120.

Grounding

- 250.122
  - Must go up if in between sizes
  - What size Cu is the equipment grounding conductor on a 60 amp circuit? - **#10 Cu**
  - What size Cu is the equipment grounding conductor on a 90 amp circuit? - **#8 Cu**

Grounding

- 250.122
  - If you have multiple circuits in a raceway, you base it on the largest overcurrent device
  - Only one equipment ground needed in a raceway
    - Unless you have an isolated ground also.
  - If you oversize phase conductors due to voltage drop, you also need to oversize ground proportionally
    - This will not be on the exam

Grounding

- 250.122
  - What size Cu is the equipment grounding conductor in a raceway that contains:
  - 2 – 40 amp circuits
  - 1 – 30 amp circuit
  - 3 – 20 amp circuits

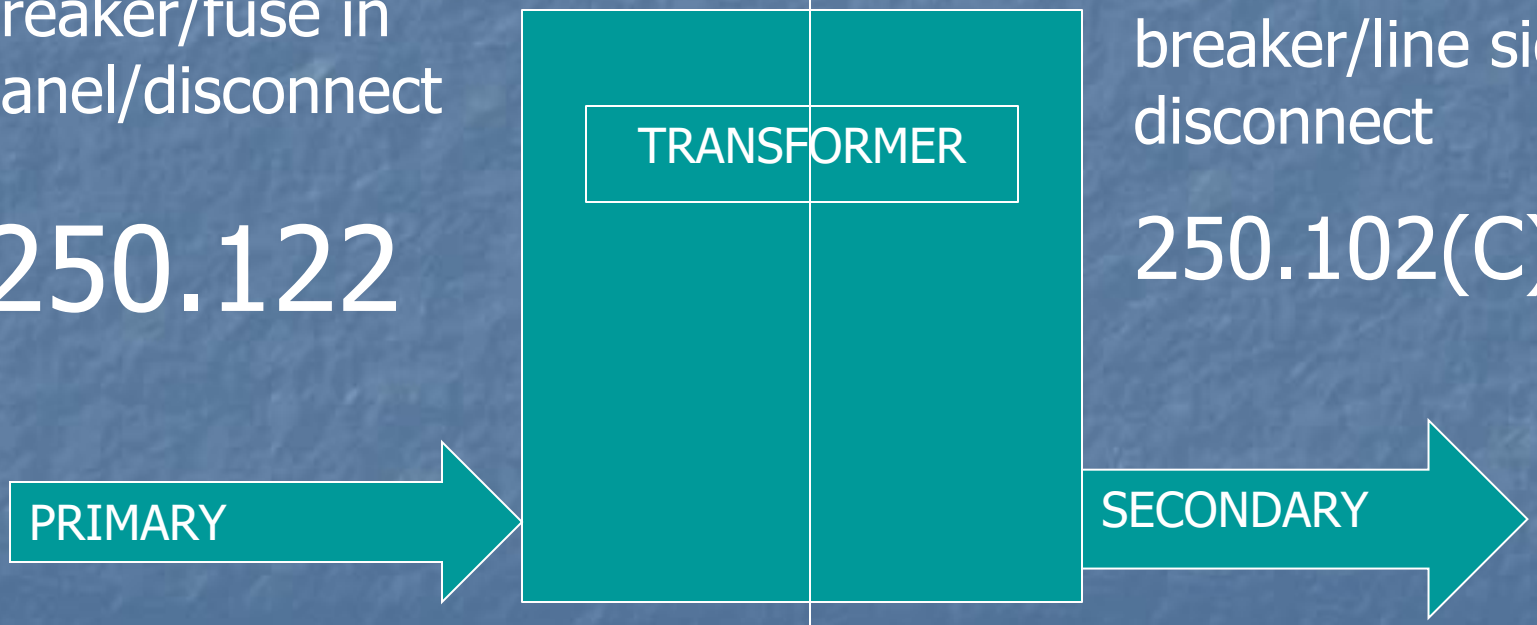
Grounding

- 250.122
  - What size Cu is the equipment grounding conductor in a raceway that contains:
  - 2 – 40 amp circuits
  - 1 – 30 amp circuit
  - 3 – 20 amp circuits
- #10 – based on a 40 amp circuit

Grounding

Protected by breaker/fuse in panel/disconnect

250.122



Conductors unprotected until they land on main breaker/line side of disconnect

250.102(C)(1)

File Attachments for Item:

EC-7 Voltage Drop (Independent Electrical Contractors)

EPE, ESI, RBO (4 hours)

Voltage Drop

This course will go over the calculations to ensure that you do not exceed the 3% or 5% voltage drop per NEC 210.19 A for both single phase and three phase circuits.

Conductor type, length, voltage, conductor size and ampacity all are factors when deciding how to properly run circuits.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Kevin Collins (Contact Name)
Organization: IEC of Greater Cincinnati (Organization/Company)
Address: 586 Kings Run Drive (Include Room Number, Suite, etc.)
City: Cincinnati State: OH Zip: 45232
E-Mail: KCollins@iec-cincy.com
Telephone: 513-542-0400 Fax: —
Course Sponsor: IEC of Greater Cincinnati

COURSE INFORMATION:

Course Title: Voltage drop

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: We will calculate the voltages at a load based on conductor size, conductor material, distance from panel, ampacity of the load and the voltage system that it is Fed From.

Number of Instructional Contact Hours that can be obtained upon completion: 4

If Multi-Session, Number of Instructional Contact Hours Per Session: —

Program Applicable for the Following Participants:

Building Official ☐ Master Plans Examiner ☐ Plumbing Plans Exam. ☐ Electrical Plans Exam. ☒ Mechanical Plans Exam. ☐ Building Inspector ☐ Fire Protection Inspector ☐ Mechanical Inspector ☐ Plumbing Inspector ☐ Non-Res IU Inspector ☐

Res Building Official ☒ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☒
Location of ESI Course: IEC of Greater Cincinnati Date(s) of ESI Course(s): 10/26/22

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
Course Sponsor:	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:	Copy of quizzes or tests to be given	
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Voltage Drop

- Write down the formula

$$Vd = \frac{2\,K\,I\,L}{CMA}$$

K= 12 for Cu*, 19 for Al*,

I = amperage,

L = length (one way)

Voltage Drop

$$L = \frac{CMA \; x \; Vd}{2 \; K \; I}$$

$$CMA = \frac{2 \; K \; I \; L}{Vd}$$

If 3 phase, replace "2" with "1.73" (square root of 3)

Table 8 Conductor Properties

Size (AWG or kcmil)	Area		Conductors							Direct-Current Resistance at 75°C (167°F)					
			Stranding			Overall				Copper				Aluminum	
				Diameter		Diameter		Area		Uncoated		Coated			
	mm²	Circular mils	Quantity	mm	in.	mm	in.	mm²	in.²	ohm/km	ohm/kFT	ohm/km	ohm/kFT	ohm/km	ohm/kFT
18	0.823	1620	1	—	—	1.02	0.040	0.823	0.001	25.5	7.77	26.5	8.08	42.0	12.8
18	0.823	1620	7	0.39	0.015	1.16	0.046	1.06	0.002	26.1	7.95	27.7	8.45	42.8	13.1
16	1.31	2580	1	—	—	1.29	0.051	1.31	0.002	16.0	4.89	16.7	5.08	26.4	8.05
16	1.31	2580	7	0.49	0.019	1.46	0.058	1.68	0.003	16.4	4.99	17.3	5.29	26.9	8.21
14	2.08	4110	1	—	—	1.63	0.064	2.08	0.003	10.1	3.07	10.4	3.19	16.6	5.06
14	2.08	4110	7	0.62	0.024	1.85	0.073	2.68	0.004	10.3	3.14	10.7	3.26	16.9	5.17
12	3.31	6530	1	—	—	2.05	0.081	3.31	0.005	6.34	1.93	6.57	2.01	10.45	3.18
12	3.31	6530	7	0.78	0.030	2.32	0.092	4.25	0.006	6.50	1.98	6.73	2.05	10.69	3.25
10	5.261	10380	1	—	—	2.588	0.102	5.26	0.008	3.984	1.21	4.148	1.26	6.561	2.00
10	5.261	10380	7	0.98	0.038	2.95	0.116	6.76	0.011	4.070	1.24	4.226	1.29	6.679	2.04
8	8.367	16510	1	—	—	3.264	0.128	8.37	0.013	2.506	0.764	2.579	0.786	4.125	1.26
8	8.367	16510	7	1.23	0.049	3.71	0.146	10.76	0.017	2.551	0.778	2.653	0.809	4.204	1.28
6	13.30	26240	7	1.56	0.061	4.67	0.184	17.09	0.027	1.608	0.491	1.671	0.510	2.652	0.808
4	21.15	41740	7	1.96	0.077	5.89	0.232	27.19	0.042	1.010	0.308	1.053	0.321	1.666	0.508
3	26.67	52620	7	2.20	0.087	6.60	0.260	34.28	0.053	0.802	0.245	0.833	0.254	1.320	0.403
2	33.62	66360	7	2.47	0.097	7.42	0.292	43.23	0.067	0.634	0.194	0.661	0.201	1.045	0.319
1	42.41	83690	19	1.69	0.066	8.43	0.332	55.80	0.087	0.505	0.154	0.524	0.160	0.829	0.253
1/0	53.49	105600	19	1.89	0.074	9.45	0.372	70.41	0.109	0.399	0.122	0.415	0.127	0.660	0.201
2/0	67.43	133100	19	2.13	0.084	10.62	0.418	88.74	0.137	0.3170	0.0967	0.329	0.101	0.523	0.159
3/0	85.01	167800	19	2.39	0.094	11.94	0.470	111.9	0.173	0.2512	0.0766	0.2610	0.0797	0.413	0.126
4/0	107.2	211600	19	2.68	0.106	13.41	0.528	141.1	0.219	0.1996	0.0608	0.2050	0.0626	0.328	0.100
250	127	—	37	2.09	0.082	14.61	0.575	168	0.260	0.1687	0.0515	0.1753	0.0535	0.2778	0.0847
300	152	—	37	2.29	0.090	16.00	0.630	201	0.312	0.1409	0.0429	0.1463	0.0446	0.2318	0.0707
350	177	—	37	2.47	0.097	17.30	0.681	235	0.364	0.1205	0.0367	0.1252	0.0382	0.1984	0.0605
400	203	—	37	2.64	0.104	18.49	0.728	268	0.416	0.1053	0.0321	0.1084	0.0331	0.1737	0.0529
500	253	—	37	2.95	0.116	20.65	0.813	336	0.519	0.0845	0.0258	0.0869	0.0265	0.1391	0.0424
600	304	—	61	2.52	0.099	22.68	0.893	404	0.626	0.0704	0.0214	0.0732	0.0223	0.1159	0.0353
700	355	—	61	2.72	0.107	24.49	0.964	471	0.730	0.0603	0.0184	0.0622	0.0189	0.0994	0.0303
750	380	—	61	2.82	0.111	25.35	0.998	505	0.782	0.0563	0.0171	0.0579	0.0176	0.0927	0.0282
800	405	—	61	2.91	0.114	26.16	1.030	538	0.834	0.0528	0.0161	0.0544	0.0166	0.0868	0.0265
900	456	—	61	3.09	0.122	27.79	1.094	606	0.940	0.0470	0.0143	0.0481	0.0147	0.0770	0.0235
1000	507	—	61	3.25	0.128	29.26	1.152	673	1.042	0.0423	0.0129	0.0434	0.0132	0.0695	0.0212
1250	633	—	91	2.98	0.117	32.74	1.289	842	1.305	0.0338	0.0103	0.0347	0.0106	0.0554	0.0169
1500	760	—	91	3.26	0.128	35.86	1.412	1011	1.566	0.02814	0.00858	0.02814	0.00883	0.0464	0.0141
1750	887	—	127	2.98	0.117	38.76	1.526	1180	1.829	0.02410	0.00735	0.02410	0.00756	0.0397	0.0121
2000	1013	—	127	3.19	0.126	41.45	1.632	1349	2.092	0.02109	0.00643	0.02109	0.00662	0.0348	0.0106

Notes:

1. These resistance values are valid **only** for the parameters as given. Using conductors having coated strands, different stranding type, and, especially, other temperatures changes the resistance.
2. Equation for temperature change: $R_2 = R_1 [1 + \alpha (T_2 - 75)]$ where $\alpha_{cu} = 0.00323$, $\alpha_{AL} = 0.00330$ at 75°C.

Voltage Drop

I have a 120 V circuit that pulls 4 amps. The conductors are #6 copper and the load is 300 feet away. What is my voltage drop?

Voltage Drop

I have a 120 V circuit that pulls 4 amps. The conductors are #6 copper and the load is 300 feet away. What is my voltage drop?

2 x 12 x 4 x 300 / 26,240 (Table 8)

= 28,800 / 26,240

= **1.09**

This circuit will lose 1.1 volts

Voltage Drop

I have a 120 V circuit that pulls 9 amps. The conductors are #8 Al and the load is 450 feet away. What is my voltage drop?

Voltage Drop

I have a 120 V circuit that pulls 9 amps. The conductors are #8 Al and the load is 450 feet away. What is my voltage drop?

2 x 19 x 9 x 450 / 16,510 =

= 153,900 / 16,510

= **9.32 volts**

Voltage Drop

- Feeders and branch circuits should be sized to maintain a maximum total voltage drop not to exceed 5% to the farthest outlet see **(215.2(A)(1)Informational note 2)**
  - 5% service to furthest point
  - 3% branch circuit panel to furthest point
- .03 x 120 = ***3.6*** is the max volts you can legally drop on a 120 V circuit
- .03 x 480 = 14.4 is the max volts you can legally drop on a 480 V circuit

Voltage Drop

I have a 120 V circuit that pulls 4 amps. The conductors are #6 copper and the load is 300 feet away. What is my voltage drop?

2 x 12 x 4 x 300 / 26,240 (Table 8)

= 28,800 / 26,240

= 1.09

This circuit will lose 1.1 volts

This would be a legal installation

Voltage Drop

I have a 120 V circuit that pulls 9 amps. The conductors are #8 Al and the load is 450 feet away. What is my voltage drop?

2 x 19 x 9 x 450 / 16,510 =

= 153,000 / 16,510

= 9.32 volts

Not allowed by code

Voltage Drop

- Question can be phrased differently:

- What is the maximum distance I can run #2 Cu on 120 V circuit that pulls 11 amps?

Voltage Drop

- What is the maximum distance I can run #2 Cu on 120 V circuit that pulls 11 amps?
- 120 x .03 = 3.6. This is the maximum volts that I can lose and still be legal.

$$L = \frac{66{,}360 \; x \; 3.6}{2 \; x \; 12 \; x \; 11}$$

$$L = \frac{238{,}896}{264}$$

L = 904.9 feet

Voltage Drop

- What is the maximum distance I can run #10 Cu on 120 V circuit that pulls 8 amps?

Voltage Drop

- What is the maximum distance I can run #10 Cu on 120 V circuit that pulls 8 amps?

$$L = \frac{10{,}380 \; x \; 3.6}{2 \; x \; 12 \; x \; 8}$$

$$L = \frac{37{,}368}{192}$$

L = 194.6

Voltage Drop

- What size copper conductors do you need for a 120 volt, 53 amp load that is 250 feet away? **K= 14**

Voltage Drop

- What size copper conductors do you need for a 120 volt, 53 amp load that is 250 feet away? **K= 14**

$$CMA = \frac{2\ x\ 14\ x\ 53\ x\ 250}{3.6}$$

$$CMA = \frac{371,000}{3.6}$$

$$CMA = \mathbf{103{,}555\ (1/0)}$$

Sean Clark

901 Beechmeadow Ln. Cincinnati, Ohio 45238

(H)513/347-9054 (C)513/800-4450

sclark@ohiovalleyelectric.com

••••••••••••••••••••••••••••

A licensed electrician with over twenty years of experience in installing, maintaining, and repairing electrical wiring, equipment, and fixtures, ensuring that work is in accordance with relevant codes, fire alarm installations, electrical control systems, and high voltage terminations. A licensed electrician with three years teaching experience in first and second year electrical.

Summary of Qualifications

- More than twenty years experience.
- Three years experience in teaching first and second year electrical.
- Thorough knowledge of electrical systems including planning additions and modifications on secondary circuits. Controls and low voltage wiring
- Able to read commercial electrical blueprints and apply NEC through the full range of commercial and industrial maintenance and construction work.
- Can use appropriate tools and diagnostic equipment to repair, install, replace, and test electrical circuits, equipment and appliances.
- Excellent ability to diagnose and repair electrical controls, industrial motor control centers, and programmable logic controllers.
- Strong desire to study and comprehend new technology.
- In-depth ability to make mathematical computations.
- Considerable ability to explain instructions and guidelines to others effectively.
- Able to assign work to employees., prioritize the work of others and organize and coordinate the work of the unit. For subs and Primes.

Professional Experience

Ohio Valley Electrical Services 2011-Present

ABC Electrical Teacher 2010-2013

Beacon Electrical Contractors 2007-2011

Ohio Valley Electrical Services 1993-2007

Electrical Superintendant/Foreman/Instructor

- First and Second year electrical instructor
- Supervision of all electrical installations of as many as 50 electricians to assure that work was done safely, efficiently, properly and within time allowed.
- Trained multiple employees in all aspects of electrical work to be able to identify an employee's strengths and weaknesses to better utilize their skills. Traced out short circuits in wiring, using test meter.
- Coordinated and implemented electrical projects within a variety of environments including plants, hospitals, schools, retail stores, public facilities, waste water treatment plants industrial buildings;

projects include both new construction and underground electrical wiring as well as renovation within existing buildings. Parking Garages and Fed Ex Ground Facilities.

- Assemble, install, test, and maintain electrical or electronic wiring, equipment, appliances, apparatus, and fixtures, using hand tools and power tools.
- Connect wires to circuit breakers, transformers, or other components.
- Construct and fabricate parts, using hand tools and specifications.
- Diagnose malfunctioning systems, apparatus, and components, using test equipment and hand tools, to locate the cause of a breakdown and correct the problem.
- Inspect electrical systems, equipment, and components to identify hazards, defects, and the need for adjustment or repair, and to ensure compliance with codes.
- Plan layout and installation of electrical wiring, equipment and fixtures, based on job specifications and local codes.
- Test electrical systems and continuity of circuits in electrical wiring, equipment, and fixtures, using testing devices such as ohmmeters, voltmeters, and oscilloscopes, to ensure compatibility and safety of system.
- Perform business management duties such as maintaining records and files, preparing reports and ordering supplies and equipment.

Education & Certifications

Master Electrician License-State of Kentucky

Journeyman Electrician's License-Hamilton, Ohio

Fire Alarm License-State of Ohio

Certified in high voltage terminations and splices

Lift, Lull, Bobcat, and Boom/scissors lift licenses

OSHA-30 card

Certified in first aid and CPR training

Certified NCCER Core Curricula Instructor

Certified NCCER Electrical Instructor

Completed 4 year apprenticeship program

1 Year Pre-apprentice school (ABC)

High School Diploma (1991)

ARCH FLASH SAFETY TRAINING

PROJECTS-SUPERVISED

$4.5mil.-MASON HIGH SCHOOL ADDITION

$250.000-3CDC-5TH RACE PARKING GARAGE

$250.000-AVONEDALE APT. COMPLEX

$100.000-MAHOGANYS AT THE BANK-

1.2mil. -PATHEON CHEMICALS

$450.000- FED EX GROUND ADDITION

$250.000-LIBERTY WAY PROJECT

$500.000-GE AT THE BANKS

$100.000 - SYCAMORE SCHOOLS/POWER/CONTROL-

$50.000 - NKU RETROFIT

$250.000- UC POWER PLANT ADDITION

$75.000 - 580BLD/ CHEMED, RETROFIT

$4.0mil - DHL- CONVEYERS/SHELL

$90.000- DOUBLE TREE AIRPORT

$2.5mil- TWIN LAKES OF MONTGOMERY

$45.000- STEINMART ANDERSON

And many small T&M jobs.

All on time and under budget