

Smoke and CO Alarms

YES Electric • NEC 2026 with NEC 2023 numbers in parentheses

Draft 1 (October 2026). This chapter is under review. Code numbers are NEC 2026. Your local inspector may use an earlier edition, so ask your journeyman which one applies. Boxes marked "Picture coming" will get drawings and photos in a later version.

YES Electric Residential Electrical Course, Phase 1 (Installation)

Code edition: this module cites NEC 2026 for the wiring. Where a section number moved, the NEC 2023 number is in parentheses. Where to put the alarms is not in the NEC. It is in the International Residential Code (IRC) Sections R314 and R315 and in NFPA 72 Chapter 29. The IRC text quoted here is the 2021 edition. The local inspector (the AHJ) may enforce an earlier or later edition of either book, so ask your journeyman which one applies before your first inspection.

Learning Objectives

When you finish this module you will be able to do these things:

1. Place smoke alarms and carbon monoxide (CO) alarms where the IRC requires them: in each bedroom, outside each sleeping area, on each story, and at the right distances from kitchens and bathrooms.
 2. Install 120 V hardwired alarms with battery backup and interconnect them with a red wire, so one alarm sounds them all.
 3. Add a wireless-interconnect alarm where no cable can be run, and know the rules for mixing it with a wired system.
 4. Know when a remodel or a panel change can trigger an alarm upgrade, and tell the customer before the inspector does.
 5. Read the date code on the back of an alarm and decide if it is past its replacement date.
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Part 1: Plain-Language Background

1.1 Why alarms are an electrician's job

Smoke and CO alarms on a new house are wired to the house power with a battery backup, and they are wired together so that one alarm sounds all of them. That makes them branch-circuit work, which is our work. They also come up on service calls. Customers call about chirping alarms, alarms that go off at 3 a.m., and alarms that sound when they cook. And when YES does work that needs a permit, the inspector may look at the alarms.

1.2 What a smoke alarm is

A smoke alarm is a single box that senses smoke and sounds a horn. It has its own sensor, its own horn, and its own battery. The IRC calls it an "alarm" because it does both jobs in one unit. A smoke "detector" is only a sensor that reports to a separate fire alarm control panel. Detectors and fire alarm panels are a different system covered by NEC Article 760 and taught in the commercial course. This module covers alarms.

Smoke alarms are listed to UL 217. Combination smoke and CO alarms are listed to both UL 217 and UL 2034 (IRC R314.1.1). The listing is printed on the back of the alarm.

1.3 Two kinds of smoke sensor

Type	How it senses	What it sees first	Nuisance trips from
Ionization	A tiny radioactive source charges the air in a chamber. Smoke particles disturb the current.	Small invisible particles from fast, flaming fires.	Cooking, toaster smoke.
Photoelectric	A light beam inside a dark chamber. Smoke scatters the light onto a sensor.	Larger visible particles from slow, smoldering fires.	Steam, dust, bugs.

Kidde's i12060 manual explains this difference and recommends that a home have both types for the most protection (Kidde i12060 User's Guide, Section 7, https://a89b8e4143ca50438f09-7c1706ba3fabeeda794725d88e4f5e57.ssl.cf2.rackcdn.com/spec_sheets/files/000/018/304/original/kidde-i12060-manual.pdf?1442933475). The type matters for placement near kitchens (Part 3.3).

1.4 What CO is and why it needs its own alarm

Carbon monoxide is a gas you cannot see, smell, or taste. It comes from fuel that does not burn completely: natural gas, propane, oil, gasoline, wood, and charcoal (First Alert SC9120B manual, "What you need to know about CO," <https://www.firstalertstore.com/store/images/pdf/sc9120b-hardwire-combination-smoke-and-carbon-monoxide-alarm.pdf>). In a house the sources are gas furnaces, gas water heaters, gas ranges, fireplaces, and cars or generators running in an attached garage. Electric appliances do not make CO.

A smoke alarm does not sense CO. A CO alarm does not sense smoke. A combination alarm does both, with two separate sensors in one housing.

1.5 Which book says what

Question	Where the answer is
Where alarms go, how many, when they must be interconnected, how they are powered	IRC R314 (smoke) and R315 (CO), which require smoke alarms to comply with NFPA 72 (IRC R314.1).
How alarms must be installed and maintained in detail	NFPA 72, National Fire Alarm and Signaling Code, Chapter 29. Free read-only access at nfpa.org after you create an account.
What circuit feeds them and how it is protected	NEC 210.12 (AFCI), NEC Chapter 3 and Article 334 for the cable.
How to wire a specific alarm, how many can be interconnected, which brands work together	The manufacturer's instruction sheet. NEC 110.3(B) requires listed equipment to be installed according to its instructions.

NEC 210.12 Informational Note No. 1 points to NFPA 72 29.9.6(3) for the secondary (battery) power rule for dwelling smoke alarms. That note is the NEC's only mention of smoke alarms.

1.6 What code Birmingham uses

The 2021 IRC is the residential code adopted in many Alabama cities. The City of Hoover adopted the 2021 IRC by ordinance (<https://www.hooveralabama.gov/DocumentCenter/View/16017/22-2556>). Alabama moved authority over the statewide residential code to the Home Builders Licensure Board on October 1, 2024, with a new code due for adoption by October 1, 2025 (Alabama Division of Construction Management, https://dcm.alabama.gov/bldg_code.aspx). That means the edition in force in Birmingham and Jefferson County today may be newer than 2021. Ask the inspector or your journeyman before you rely on the distances in this module.

Part 2: Where Alarms Are Required

2.1 Smoke alarm locations (IRC R314.3)

The 2021 IRC R314.3 requires smoke alarms in these locations (text from the ICC code and commentary excerpt posted by Routt County, Colorado, <https://www.co.routt.co.us/DocumentCenter/View/15203/Smoke-and-CO-Alarms-IRC?bidId=>):

1. In each sleeping room.
2. Outside each separate sleeping area in the immediate vicinity of the bedrooms.
3. On each additional story of the dwelling, including basements and habitable attics, but not crawl spaces and uninhabitable attics. In a split-level house with no door between levels, an alarm on the upper level covers the adjacent lower level if the lower level is less than one full story below.

4. Not less than 3 ft horizontally from the door or opening of a bathroom that contains a bathtub or shower, unless that would prevent placing a required alarm.
5. In the hallway and in the room open to the hallway, where a room open to a hallway serving bedrooms has a ceiling 24 in. or more higher than the hallway ceiling.

Why each one exists, in plain words:

Location	Why
Each bedroom	A fire that starts in the bedroom wakes the person in it.
Outside each sleeping area	The hall is the escape path. An alarm there warns everyone before smoke blocks the way out.
Each story, including the basement	A fire on another floor gets noticed before it climbs the stairs.
3 ft from a tub or shower bathroom door	Steam sets alarms off. People who get false alarms pull the battery.
Hall plus high-ceiling room	Smoke collects in a high ceiling first. Without an alarm there, the hall alarm may not sound until the hall is full of smoke.

2.2 Distance from cooking appliances (IRC R314.3.1)

The 2021 IRC R314.3.1 says smoke alarms shall not be installed in these locations, unless that would prevent placing an alarm required by R314.3:

Alarm type	Minimum horizontal distance from a permanently installed cooking appliance
Ionization	20 ft
Ionization with an alarm-silencing (hush) switch	10 ft
Photoelectric	6 ft
Listed and marked "helps reduce cooking nuisance alarms"	6 ft

The ICC commentary says these distances come from a 2008 task group report on nuisance alarms and match NFPA 72 Section 29.8.3.4.

In practice YES installs photoelectric or "cooking nuisance" marked alarms near kitchens. They can go as close as 6 ft to the range. An ionization alarm would need to be 20 ft away, which in a small house can push it out of the hallway where it is required.

2.3 CO alarm locations (IRC R315)

The 2021 IRC R315.2.1 requires CO alarms in new construction where either of these is true:

1. The dwelling unit contains a fuel-fired appliance (gas furnace, gas water heater, gas range, gas or wood fireplace).
2. The dwelling unit has an attached garage with an opening that communicates with the dwelling.

A house that is all-electric with a detached garage, or no garage, does not need a CO alarm under this section.

Where they are required, R315.3 says CO alarms go:

1. Outside each separate sleeping area in the immediate vicinity of the bedrooms.
2. Inside the bedroom, if a fuel-burning appliance is located in the bedroom or its attached bathroom.

A combination smoke and CO alarm may be used in place of a CO alarm (R315.4). Most YES installs put a combination alarm in the hall outside the bedrooms, which satisfies both R314.3 item 2 and R315.3.

The First Alert SC9120B manual says NFPA recommends a CO alarm centrally located outside each sleeping area, and it recommends extra CO alarms in each bedroom and on every level for added protection. Those extras are optional unless the local code requires them.

2.4 Where alarms work poorly

These are manufacturer recommendations, not code, but following them prevents callbacks. From the Kidde i12060 manual (Section 2, "Locations to Avoid") and the First Alert SC9120B manual:

1. Keep smoke alarms out of garages. Car exhaust sets them off.
2. Keep them out of areas below 40°F or above 100°F, such as unfinished attics and garages.
3. Keep them out of very dusty or very humid areas.
4. Keep them at least 3 ft from the door to a kitchen, the door to a bathroom with a tub or shower, forced-air supply registers, ceiling fans, and whole-house fans (Kidde).
5. Keep them at least 4 in. from the peak of an A-frame ceiling (Kidde).
6. Keep them away from fluorescent lights, which can cause electrical noise (Kidde).

2.5 Mounting position on the ceiling or wall

From the Kidde i12060 manual, Section 1, quoting NFPA 72 where noted:

Situation	Rule
Ceiling mount	Preferred. At least 4 in. from the side wall. Center of the room is best.
Wall mount	On an inside wall, with the top edge of the alarm between 4 in. and 12 in. below the ceiling. Battery door at the bottom.
Sloped, peaked, or cathedral ceiling	On the high side of the room if the slope is more than 1 ft in 8 ft. Within 3 ft of the peak, measured horizontally, but not within 4 in. of the peak.
Long hallway or room	Kidde says an alarm at each end if the hall or room is more than 30 ft long. First Alert says 40 ft. Use the number in the instructions for the alarm you are installing.
Stairs	An alarm to cover each stairway, because stairs act like chimneys. First Alert suggests the top of the first-to-second-floor stairs and the bottom of the basement stairs.

Picture coming: Two-story house section drawing, cut through the middle from front to back. Second floor: three bedrooms, each with a ceiling smoke alarm marked "S"; the hall outside the bedrooms has a combination alarm marked "S/CO"; a hall bathroom with a shower has a dashed 3 ft circle around its door and the hall alarm sits outside the circle. First floor: living room with a ceiling 24 in. higher than the adjacent hall, with an "S" in both the hall and the living room and a callout "R314.3 item 5"; the kitchen range has dashed arcs at 6 ft (labeled "photoelectric") and 20 ft (labeled "ionization"); an "S" alarm in the first-floor hall sits outside the 6 ft arc. Basement: one "S" at the bottom of the stairs. Attached garage with a door into the house: no alarm in the garage, and a note "Attached garage + fuel appliance = CO alarm required." A gas furnace in the basement is labeled "fuel-fired appliance."

Part 3: When an Upgrade Is Triggered

3.1 New construction and additions

On a new house, every alarm in R314.3 and R315.3 is required, hardwired with battery backup, and interconnected (R314.4, R314.6, R315.5, R315.6). An addition counts too. R314.2.2 and R315.2.2 say that when alterations, repairs, or additions requiring a permit occur, the dwelling unit shall be equipped with alarms located as required for new dwellings.

3.2 Remodels and other permitted work

The same R314.2.2 and R315.2.2 apply to remodels. The exceptions in the 2021 IRC are narrow:

Work	Smoke alarm upgrade required? (R314.2.2)	CO alarm upgrade required? (R315.2.2)
Exterior work: roofing, siding, windows, doors, porch, deck	No (Exception 1).	No (Exception 1).
Plumbing work	No (Exception 2).	No (Exception 2).
Mechanical (HVAC) work	No (Exception 2).	No, if the mechanical system is not fuel-fired (Exception 3). A new gas furnace does trigger it.
Interior remodel needing a building permit, such as a kitchen or bath	Yes.	Yes, if the house has a fuel-fired appliance or an attached garage.
Electrical-only permit, such as a panel change	The IRC text lists no exception for electrical work. Whether your AHJ applies R314.2.2 to an electrical-only permit is a local decision. Ask the inspector.	Same.

For existing houses the IRC relaxes the power and wiring rules:

1. R314.6 Exception 2 and R315.6 Exception 2 allow alarms installed under the alteration rules to be battery powered.
2. R315.5 Exception says interconnection of CO alarms in existing areas is not required where the work does not remove interior wall or ceiling finishes, unless an attic, crawl space, or basement gives access for interconnection without removing finishes.
3. R314.4 and R315.5 both allow listed wireless alarms in place of physical interconnection, where all alarms sound when one is activated.

The 2021 R314.4 text in the source used for this module shows no "existing finishes" exception for smoke alarm interconnection. Earlier IRC editions had one. Check the edition your AHJ uses.

3.3 What to tell the customer

Before YES pulls a permit for any interior work, the technician or estimator should walk the house and count the alarms. If the house is short, the customer hears it from us at the estimate, not from the inspector at the final. A failed final costs a second trip.

Say it plainly: "When we pull the permit for this work, the inspector can require smoke alarms in every bedroom, in the hall, and on every floor, and a CO alarm because you have a gas furnace. You have two. I'll put the rest on the estimate so the inspection passes the first time."

Part 4: Installing Hardwired Interconnected Alarms (Step by Step)

4.1 The circuit

1. Feed smoke alarms from a 15 A or 20 A, 120 V branch circuit that is on all the time. The Kidde i12060 manual requires a non-switchable circuit. The First Alert SC9120B manual says the circuit cannot be turned off by a switch, dimmer, or GFCI. Never put an alarm on a switched leg or a dimmer.
2. The circuit is almost always a bedroom or hallway lighting or receptacle circuit, because those rooms are where the alarms are. NEC 210.12(B) requires AFCI protection for 120 V, 15 A and 20 A branch circuits supplying outlets or devices in bedrooms, hallways, family rooms, living rooms, and the other listed rooms. A smoke alarm is a device in one of those rooms, so its circuit gets AFCI protection.
3. Do not put alarms on the load side of a GFCI receptacle. The Kidde manual says the circuit must not be GFCI protected. A GFCI trip would leave the alarms on battery with no warning to the customer.
4. All interconnected alarms must be on the same circuit. Both Kidde and First Alert require this. The interconnect signal is referenced to the neutral of that one circuit.
5. Why use a lighting circuit people use every day: if the breaker trips, the customer notices the dark bedroom and resets it. A dedicated alarm circuit can sit tripped for months with the alarms running on batteries. NFPA 72 has specific rules about the circuit for alarms. The section number was not verified for this module, so follow your journeyman and the AHJ on whether a dedicated circuit is wanted.

Safety warning: before you work on an existing alarm circuit, prove it dead with the live-dead-live procedure in R1.1. Alarm circuits in old houses are often tapped from an unexpected breaker.

4.2 Cable and boxes

1. Run 14-3 with ground on a 15 A circuit or 12-3 with ground on a 20 A circuit between alarms. The black is the hot, the white is the neutral, the red is the interconnect, and the bare is the ground.
2. Run 14-2 or 12-2 only from the circuit's last receptacle or switch box to the first alarm, if the interconnect does not need to go back there.
3. The interconnect must be in the same cable or raceway as the power conductors. Kidde's instructions require it, and NEC 300.5(B) (2023: 300.3(B)) requires all conductors of the same circuit to be in the same raceway or cable.
4. Secure NM cable within 12 in. of each box and at intervals not over 4-1/2 ft (NEC 334.30). See R1.3 for setbacks and nail plates.
5. Mount each alarm on a listed box. The First Alert SC9120B fits a standard junction box up to 4 in. A 4 in. octagon box, a 4 in. round pancake box, or a single-gang box works for most brands. Check the alarm's instructions.

- Kidde limits the total interconnect wire from the first unit to the last to 1,000 ft and the interconnect resistance to 10 ohms. First Alert says the total interconnect wire should be less than 1,000 ft.

4.3 Wiring each alarm

Most hardwired alarms come with a plug-in wiring harness (a "pigtail") that has a black, a white, and a red lead.

- Turn off the breaker and prove the box dead (R1.1, Part 3).
- Strip the cable jacket so 6 in. or more of free conductor sticks out of the box.
- Make up the grounds first. Join all bare grounds in the box with a pigtail to the box's ground screw if the box is metal. Most alarm harnesses have no ground lead, and the alarm housing is plastic.
- Join the harness black lead to the black (hot) conductors in the box with a wire connector.
- Join the harness white lead to the white (neutral) conductors.
- Join the harness red lead to the red (interconnect) conductors.
- On an alarm used alone with no interconnect, do not connect the red lead to anything. Kidde says to leave the factory cap on the red lead so it cannot touch metal parts or the box.
- Fold the splices into the box.
- Screw the mounting bracket to the box. Kidde marks an "A" line on the bracket that goes parallel to the hallway on a ceiling mount, or horizontal on a wall mount.
- Plug the harness into the alarm until the latches click.
- Install or connect the backup battery. Many alarms ship with a pull tab. Pull it all the way out. Some alarms will not close on the bracket without a battery.
- Twist the alarm onto the bracket until it locks.

Harness lead	Connect to	Function
Black	Black hot conductor	120 V power
White	White neutral conductor	Return
Red	Red conductor of the 3-wire cable	Interconnect signal to all other alarms

Picture coming: Interconnected alarm wiring diagram. Left: a panel with a 15 A single-pole combination AFCI breaker labeled "AFCI, 210.12(B)," its pigtail landed on the neutral bar. 14-2 NM runs to the last receptacle box, then 14-3 NM runs to Alarm 1, Alarm 1 to Alarm 2, Alarm 2 to Alarm 3. At each alarm box, the black, white, and red harness leads are drawn connected to the black, white, and red cable conductors with wire connectors. Grounds are joined in each box. A callout on Alarm 3 says "Last alarm: red leads still joined; only cap the red when an alarm is used alone." A callout on the cable says "Interconnect in the same cable as power, 300.5(B)."

4.4 Testing

- Turn on the breaker.

2. Check that the green power light is on at every alarm.
3. Press and hold the test button on the first alarm for 5 seconds or more (Kidde). Every interconnected alarm should sound.
4. Repeat the test from the last alarm in the chain. If alarm 3 sets off 1 and 2, the red wire is continuous both ways.
5. Stand an arm's length from the alarm when you test. Kidde rates the horn at 85 dB. First Alert rates its horn at 85 dB at 10 ft.
6. On a Kidde alarm, only the alarm you pressed will flash its red light fast. The others sound but do not flash. That tells the customer which alarm started an alarm (Kidde Section 4).
7. With the alarms sounding, flip the breaker off. The alarms should keep working on battery. Flip it back on.
8. Leave the manuals with the customer. First Alert says the installer must leave the manual, or a copy, with the end user.

4.5 Brand compatibility

Alarms from different brands cannot be mixed on one red wire. Kidde says connecting Kidde products to a non-specified manufacturer's interconnect system could cause nuisance alarms, failure to alarm, or damage. First Alert's manual lists the BRK and First Alert models the SC9120B is compatible with. When you replace one alarm in an existing interconnected system, match the brand and check the compatibility list, or replace every alarm in the chain.

Kidde allows up to 24 Kidde devices on one interconnect but says the system should not exceed the NFPA limit of 12 smoke alarms and 18 alarms total (smoke, heat, CO). First Alert allows 18 compatible alarms with no more than 12 smoke alarms. The 12 and 18 numbers come from NFPA 72 according to both manufacturers.

Part 5: Wireless Interconnect

5.1 When to use it

Use wireless-interconnect alarms when you need interconnection in a finished house and running 3-wire cable between alarms would mean opening walls and ceilings. The IRC allows listed wireless alarms in place of physical interconnection when all alarms sound when one is activated (R314.4, R315.5).

5.2 How Kidde does it

The Kidde RF-SM-ACDC is a 120 V hardwired alarm that also talks by radio (Kidde RF-SM-ACDC User's Guide, <https://media.distributordatasolutions.com/kidde/2016q4/aa041813f0b80866ddc137612b9daba5db8167f3.pdf>). Its rules:

1. Each wireless device has an 8-position dip switch, under the battery door on this model.

2. Before you power any device, set all of them to the same random switch pattern. Do not use the factory pattern, because a neighbor's alarms may be on it.
3. Install batteries to power each unit. The alarm reads the ID only when first powered. If you change the switches later, remove power for at least 30 seconds before powering it again.
4. Hold the test button on one unit for 5 seconds. All units should alarm. Wireless alarms can take up to 12 seconds to respond to a remote test.
5. To add wireless to an existing hardwired interconnected system, replace only one of the hardwired alarms with an RF-SM-ACDC. That unit bridges the red wire to the radio. Never put two RF-SM-ACDC units on the same red wire. They will trigger each other and alarm until one is disconnected.
6. If the existing hardwired alarms are not interconnected (two wires only, no red), you can replace each of them, up to 12, with an RF-SM-ACDC and leave every red lead capped.
7. Wireless communication can be interrupted, so the customer must test the alarms weekly.

5.3 How to tell what kind of system a house has

Kidde's wireless setup guide (<https://images.thdstatic.com/catalog/pdfImages/75/754f1f58-123b-41f2-91ea-f15db0cf4974.pdf>) gives a simple test:

What you see behind the alarm	Press test, do the others sound?	System type
No wires, battery only	No	Battery operated
Black and white wires only	No	Hardwired, not interconnected
Black, white, and a third wire (red, orange, or yellow)	Yes	Hardwired with interconnect

Part 6: Replacing Alarms and Reading the Date

6.1 How long alarms last

Kidde's manual says NFPA and the manufacturer recommend replacing the alarm ten years from the date code. First Alert's product page says all smoke alarms need to be replaced every 10 years, and its older CO and combination alarms every 5 to 7 years. Newer "10-year" CO and combination models are made. The life of a CO alarm depends on the model. Many CO alarms sound an "end of life" chirp pattern when the sensor expires. Read the label on the alarm in front of you.

6.2 Reading the date code

1. Twist the alarm off its bracket.
2. Look on the back label for "Date Code," "Manufactured," or "Mfg Date." Some brands print "Replace by" with a date.

3. If the date is a year and month, add 10 years for a smoke alarm. That is the replace-by date.
4. If the label gives only a code you cannot read, call the manufacturer or look it up on their site. An alarm with no readable date is treated as past its date.
5. Write the date on the work order.

Picture coming: The back label of a hardwired smoke alarm, close up. The model number, "UL 217," "120VAC 60Hz," and "Date Code 2015 MAR 04" are printed. The date code is circled in red with a callout "Made March 2015. Replace by March 2025." A second smaller label at the bottom reads "Replace unit 10 years from date code" and is also circled.

6.3 Replacing an old hardwired alarm, step by step

1. Ask the customer how many alarms the house has and whether they all go off together. Press test on one to find out.
2. Read the date code on each alarm. If one is past ten years, the rest from the same build almost always are too. Quote all of them.
3. Note the brand and model. Check the new alarm's instructions for its compatibility list.
4. Turn off the breaker and prove the box dead.
5. Unplug the old harness from the old alarm. Cut the old harness off at the wire connectors or unscrew the connectors and remove it. Old harness plugs rarely fit new alarms.
6. Wire the new harness as in Part 4.3, black to black, white to white, red to red.
7. Mount the new bracket, plug in, connect the battery, twist on.
8. Repeat for each alarm, then test from the first and last alarm as in Part 4.4.
9. Take the old alarms away. Ionization alarms contain a very small amount of americium-241. Kidde's i12060 says the purchaser is exempt from NRC regulatory requirements. Follow the manufacturer's disposal instructions on the alarm.

Part 7: Worked Examples

Example 1: Counting alarms on a two-story house

A house has a second floor with three bedrooms off one hall and a hall bath with a shower. The first floor has a kitchen with a gas range, a living room with an 11 ft ceiling open to an 8 ft hall that does not serve bedrooms, and a master bedroom off a separate short hall. There is a full basement with a gas furnace and an attached garage with a door into the kitchen.

Count under 2021 IRC R314.3 and R315:

Location	Required by	Alarm
Bedroom 2, Bedroom 3, Bedroom 4 (upstairs)	R314.3 item 1	3 smoke
Upstairs hall outside bedrooms	R314.3 item 2 (smoke), R315.3 (CO)	1 combination smoke/CO
Master bedroom (first floor)	R314.3 item 1	1 smoke
Hall outside the master bedroom	R314.3 item 2, R315.3	1 combination smoke/CO
First floor (story requirement)	R314.3 item 3	Covered by the master hall alarm
Basement	R314.3 item 3	1 smoke
Living room high ceiling	R314.3 item 5	Not triggered. That item applies only where the room is open to a hallway serving bedrooms. This hall does not serve bedrooms.

Total: 6 smoke alarms and 2 combination alarms, 8 units, all on one AFCI circuit and interconnected. Two separate sleeping areas means two "outside each sleeping area" alarms. CO is required because the house has a gas furnace, a gas range, and an attached garage with a door, any one of which triggers R315.2.1. Kidde's limit of 12 smoke alarms and 18 total is not reached.

Example 2: How close to the range

The hall outside the master bedroom passes the kitchen. The only ceiling spot in that hall that is outside the bathroom's 3 ft zone is 8 ft from the edge of the gas range, measured horizontally.

- An ionization alarm needs 20 ft (R314.3.1 item 1). It cannot go here unless no other spot works.
- An ionization alarm with a hush button needs 10 ft (item 2). It cannot go here.
- A photoelectric alarm needs 6 ft (item 3). 8 ft is more than 6 ft, so it can go here.
- An alarm marked "helps reduce cooking nuisance alarms" needs 6 ft (item 4). It can go here.

Install a photoelectric combination smoke/CO alarm at that spot.

Example 3: The interconnect resistance limit

Kidde limits interconnect wire resistance to 10 ohms. NEC Chapter 9 Table 8 gives 3.07 ohms per 1,000 ft for solid uncoated 14 AWG copper at 75°C. Kidde also limits the run from the first unit to the last to 1,000 ft. At the maximum length the red wire measures about 3.07 ohms, which is under the 10 ohm limit. On a normal house with 150 ft of red wire, the resistance is $150 \div 1,000 \times 3.07 = 0.46$ ohm.

If a red wire in an existing system meters far above that on a continuity test with power off and the alarms unplugged, the red has a bad splice somewhere.

Example 4: Is it past its date?

Today is October 2026. You find three alarms. The date codes read 2014-11, 2016-06, and 2019-02.

Date code	Replace by (10 years)	Past its date in October 2026?
2014-11	2024-11	Yes
2016-06	2026-06	Yes
2019-02	2029-02	No

Two alarms need replacement now. The third is mixed into an interconnected chain, so check that the new alarms are compatible with it, or quote all three so the system is one brand and one age.

Example 5: Load on the circuit

The Kidde i12060 is rated 80 mA maximum per alarm. Eight alarms draw at most $8 \times 0.080 \text{ A} = 0.64 \text{ A}$, which is about 77 W at 120 V. Alarms add almost no load to a 15 A lighting circuit. You do not need a separate circuit for load reasons.

Part 8: Common Mistakes

Mistake	What goes wrong	Do this instead
Alarm on a switched leg or dimmer.	The customer turns off the light and the alarm loses AC power.	Feed alarms from an unswitched hot.
Alarm downstream of a GFCI receptacle.	A GFCI trip puts the alarms on battery with no warning. Kidde says the circuit must not be GFCI protected.	Feed from an AFCI-protected bedroom or hall circuit with no GFCI upstream.
Interconnected alarms on two different circuits.	The interconnect may not work, or may damage alarms. Both Kidde and First Alert require one circuit.	Put every interconnected alarm on one breaker.
Running the red interconnect as a separate wire.	Violates the alarm instructions and NEC 300.5(B).	Use 14-3 or 12-3 cable.
Mixing brands on one red wire.	Nuisance alarms, no alarm, or damaged units.	Match brand and check the compatibility list.
Two Kidde wireless bridge alarms on one red wire.	They trigger each other and alarm continuously.	One RF-SM-ACDC per wired system.
Ionization alarm within 20 ft of the range.	Nuisance alarms every time the customer cooks. They pull the battery.	Photoelectric or "cooking nuisance" marked alarm at 6 ft or more.
Alarm at the bathroom door.	Steam sets it off after every shower.	3 ft or more from the door of a bathroom with a tub or shower.
Wall-mounted alarm too low, or with the battery door up.	Smoke reaches it late. Kidde says incorrect wall orientation decreases effectiveness.	Top edge 4 in. to 12 in. below the ceiling, battery door down.
Smoke alarm in the garage.	Car exhaust trips it.	Leave garages without a smoke alarm. Ask the journeyman about a heat alarm if the customer wants coverage there.
Forgetting CO on a house with gas.	Fails inspection under R315.	Check for fuel-fired appliances and an attached garage on every permit job.
Replacing one old alarm in a chain of ten-year-old alarms.	The customer pays twice when the others fail next month.	Read every date code and quote them together.
Capping the red lead on alarms that are supposed to be interconnected.	Only the alarm near the fire sounds.	Cap the red only on a single-station alarm. Test from the first and last alarm.
Leaving without the manuals.	The customer does not know how to test or hush.	Leave every manual.

8.1 When the alarms are fine and the power is not

Kuhlman's Somerville call (pp. 101–102) is a reminder that false alarms are not always the alarm's fault. A customer in a three-family house reported smoke alarms going off often and light bulbs burning out early in all three units. Kuhlman treated both symptoms as a voltage problem, because line-voltage alarms can false-alarm on large voltage swings. He measured 119 V on one leg and 114 V on the other, and found more current on the water-pipe bonding conductor (9 A) than on the service neutral (6 A). Running a shop vacuum added about 5 A to the water-pipe bond, while the neutral barely changed and one leg dropped a few more volts. That pattern pointed to a bad service neutral. The utility found and replaced damaged underground conductors, and the alarm and bulb problems stopped.

If several alarms in a house false-alarm and bulbs fail early, measure leg-to-neutral voltage at the panel under load before you replace alarms. A lost or loose neutral is dangerous. Stop and call your journeyman, and see R2.5 for the full procedure.

Part 9: Safety Warnings in One Place

1. Prove the alarm circuit dead before you open a box. The breaker label may be wrong (R1.1, Part 3).
 2. Stand an arm's length from an alarm when you press test. The horn is 85 dB.
 3. Never test an alarm with an open flame. Kidde warns this can damage the alarm or start a fire. Use the test button, or a listed aerosol smoke tester if your journeyman supplies one.
 4. Work from a stepladder set up as in R1.1, Part 5. Ceiling alarm work is ladder work.
 5. Never pull a battery or disconnect an alarm and leave without telling the customer. A disconnected alarm protects no one.
 6. If a CO alarm is sounding when you arrive, get everyone out of the house and tell the customer to call the gas company or 911. Do not stay inside to diagnose it.
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Part 10: Field Exercise

Do this exercise with a journeyman watching. Allow about three hours.

Part A: Mark the alarm locations on a house plan (45 minutes)

1. Your journeyman gives you a printed floor plan of a real or sample house with at least two stories, three bedrooms, a kitchen, and at least one bathroom with a tub or shower.
2. Circle every fuel-fired appliance on the plan (gas furnace, gas water heater, gas range, gas fireplace). Note whether the garage is attached with a door into the house.
3. Mark an "S" at every smoke alarm required by R314.3. Write the item number next to each one.

4. Draw a 3 ft arc around the door of every bathroom with a tub or shower. Move any alarm that falls inside the arc, unless moving it would leave a required location uncovered.
5. Draw a 6 ft arc and a 20 ft arc around the range. Decide which alarm type goes at each location inside the 20 ft arc.
6. Look for any room open to the bedroom hallway with a ceiling 24 in. or more higher than the hall. Mark an extra "S" if you find one.
7. Mark a "CO" outside each sleeping area if R315.2.1 applies. Mark one in a bedroom if a fuel-burning appliance is in that bedroom or its attached bath.
8. Count the total. Check it against the 12 smoke and 18 total interconnect limit.
9. Have your journeyman check the plan. Fix anything wrong.

Part B: Wire three interconnected alarms on the training wall (75 minutes)

Materials: a 15 A single-pole combination AFCI breaker for the training panel, 14-2 and 14-3 NM-B cable, three 4 in. round or octagon boxes, three hardwired alarms of the same brand with harnesses (one may be a combination smoke/CO), wire connectors, staples.

1. Turn off the training panel and prove it dead.
2. Install the AFCI breaker. Land its hot on the breaker terminal and its white pigtail on the neutral bar, torqued to the values on the breaker label (110.14(D)).
3. Mount the three boxes on the training ceiling or wall at least 4 in. from any wall-ceiling corner.
4. Run 14-2 from the panel to the first alarm box. Run 14-3 from box 1 to box 2 and from box 2 to box 3. Staple within 12 in. of each box and every 4-1/2 ft or less.
5. Make up each box: grounds together first, then black to black, white to white, red to red, with each alarm's harness.
6. Mount the brackets, plug in the alarms, connect the batteries, and twist them on.
7. Turn on the breaker. Check the green light on all three.
8. Press test on alarm 1. All three must sound.
9. Press test on alarm 3. All three must sound.
10. Turn off the breaker with the alarms quiet. Press test on alarm 2. All three must sound on battery power.
11. Turn the breaker back on.
12. Press the AFCI breaker's test button. The breaker should trip, and the alarms should stay powered by battery. Reset the breaker.

Part C: Add one wireless alarm (30 minutes)

Use a wireless bridge alarm that is listed as compatible with the brand you wired in Part B, such as a Kidde RF-SM-ACDC on a Kidde system, plus one battery wireless alarm of the same family.

1. Turn off the breaker and prove alarm 3's box dead.
2. Before powering anything, set the dip switch ID on the wireless bridge and the battery wireless alarm to the same random pattern.

3. Replace alarm 3 with the wireless bridge alarm, connecting black, white, and red.
4. Install the battery in the battery-only wireless alarm and mount it across the room.
5. Turn on the breaker.
6. Press test on alarm 1. Alarm 2, the bridge, and the wireless alarm must all sound. Allow up to 12 seconds for the wireless alarm.
7. Press test on the wireless alarm. All four must sound.
8. Explain to your journeyman why only one bridge alarm may be on the red wire.

Part D: Read a date code (15 minutes)

1. Take an existing alarm off a wall at the shop or on a customer's house with permission.
 2. Find the date code on the back.
 3. Write the manufacture date and the replace-by date (date plus 10 years for a smoke alarm, or the label's date for a CO or combination alarm).
 4. Say whether it is past its date as of today.
 5. Write the two-sentence explanation you would give the customer, for example: "This alarm was made in March 2015, and the manufacturer says to replace it after ten years. It is past that date, and the others in the house are the same age."
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Part 11: NEC and Other Cross-References

Reference	What it covers
NEC 210.12(A)	Means of AFCI protection: combination AFCI breaker, branch/feeder AFCI plus outlet AFCI, and the other listed combinations.
NEC 210.12(B)	AFCI protection required for 120 V, 10 A, 15 A, and 20 A branch circuits supplying outlets or devices in dwelling bedrooms, hallways, living rooms, family rooms, kitchens, closets, laundry areas, and similar areas. Informational Note No. 1 points to NFPA 72 29.9.6(3) for smoke alarm secondary power.
NEC 210.12(E)	AFCI protection when branch-circuit wiring in those areas is modified, replaced, or extended, with an exception for extensions of 6 ft or less with no added outlets or devices. See R1.12.
NEC 300.5(B) (2023: 300.3(B))	All conductors of the same circuit in the same raceway or cable. Keeps the red interconnect in the same cable as the power.
NEC 334.30	NM cable secured within 12 in. of every box and at intervals not over 4-1/2 ft.
NEC 110.3(B)	Listed equipment installed according to its instructions. Makes the alarm manufacturer's limits enforceable.
NEC Chapter 9, Table 8	Conductor resistance, used in Example 3.
IRC R314 (2021)	Smoke alarms: listing, where required, locations, cooking-appliance distances, interconnection, combination alarms, power source.
IRC R315 (2021)	CO alarms: listing, where required, location, combination alarms, interconnection, power source.
NFPA 72 Chapter 29	Single- and multiple-station alarms and household signaling systems. 29.8.3.4 (cooking appliance distances, per ICC commentary). 29.9.6(3) (secondary power, per NEC 210.12 informational note).
NFPA 720	Household CO detection systems, referenced by IRC R315.7.1 when a CO detection system is used in place of alarms.

The placement rules in this module are not in the NEC. An electrical inspector may not check them, but the building inspector will.

Part 12: End-of-Chapter Checklist

- [] I can list the five smoke alarm locations in 2021 IRC R314.3.
- [] I can give the cooking-appliance distances: 20 ft ionization, 10 ft ionization with hush, 6 ft photoelectric, 6 ft "cooking nuisance" marked.
- [] I know the 3 ft rule for bathroom doors with a tub or shower.

- [] I know the two conditions that require CO alarms in new construction: a fuel-fired appliance, or an attached garage with an opening into the house.
 - [] I know CO alarms go outside each sleeping area, and inside a bedroom with a fuel-burning appliance in it or its bath.
 - [] I know which permitted work triggers an alarm upgrade under R314.2.2 and R315.2.2, and that I ask the AHJ about electrical-only permits.
 - [] I feed alarms from an unswitched, AFCI-protected circuit with no GFCI upstream, all on one breaker.
 - [] I run 14-3 or 12-3 so the red interconnect is in the same cable as power.
 - [] I wire black to black, white to white, red to red, and cap the red only on a single-station alarm.
 - [] I test from the first and the last alarm, and on battery power.
 - [] I never mix brands on one interconnect, and I use only one wireless bridge alarm on a wired system.
 - [] I mount wall alarms with the top edge 4 in. to 12 in. below the ceiling, battery door down.
 - [] I can read a date code and figure the replace-by date.
 - [] I leave every manual with the customer.
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Sources

- International Code Council, 2021 International Residential Code, Sections R314 and R315, as reproduced in the ICC Code and Commentary excerpt posted by Routt County, Colorado: <https://www.co.routt.co.us/DocumentCenter/View/15203/Smoke-and-CO-Alarms-IRC?bidId=.> R314.3 and R314.3.1 wording cross-checked against the New Jersey 2021 IRC errata/ amendment document (https://www.nj.gov/dca/codes/codereg/pdf_misc_codes/IRC_2021_err.pdf) and UpCodes (<https://up.codes/s/smoke-alarms-and-heat-detection>).
- NFPA 72, National Fire Alarm and Signaling Code, Chapter 29. Not read directly for this module. Cited only where the NEC or the ICC commentary cites a specific section.
- NEC 2026 text: 110.3(B), 210.12, 300.5(B), 334.30, Chapter 9 Table 8.
- Kidde i12060 Smoke Alarm User's Guide, P/N 820-0394-EN Rev. D: https://a89b8e4143ca50438f09-7c1706ba3fabeeda794725d88e4f5e57.ssl.cf2.rackcdn.com/spec_sheets/files/000/018/304/original/kidde-i12060-manual.pdf?1442933475
- Kidde RF-SM-ACDC AC Wireless Smoke Alarm User's Guide, P/N 820-0833 Rev. C: <https://media.distributordatasolutions.com/kidde/2016q4/aa041813f0b80866ddc137612b9daba5db8167f3.pdf>
- Kidde Wireless Setup Guide: <https://images.thdstatic.com/catalog/pdfImages/75/754f1f58-123b-41f2-91ea-f15db0cf4974.pdf>
- First Alert (BRK) SC9120B Smoke and CO Alarm User's Manual: <https://www.firstalertstore.com/store/images/pdf/sc9120b-hardwire-combination-smoke-and-carbon-monoxide-alarm.pdf>

- First Alert SC9120B product page and FAQ: <https://www.firstalertstore.com/store/products/hardwire-combination-smoke-carbon-monoxide-alarm-sc9120b.htm>
 - City of Hoover Ordinance 22-2556 (2021 IRC adoption): <https://www.hooveralabama.gov/DocumentCenter/View/16017/22-2556>
 - Alabama Division of Construction Management, building code page: https://dcm.alabama.gov/bldg_code.aspx
 - Kuhlman, Residential Electrical Troubleshooting (2019). "Arc-Fault Circuit Interrupter (AFCI)," p. 38: Kuhlman describes a 2008–2009 call where interconnected smoke alarms on an AFCI circuit went off at random. Replacing the alarms did not help. Swapping in a standard breaker as a test stopped the alarms, and the fix his shop kept was a different alarm brand on the AFCI circuit, because bedroom wiring still needed AFCI protection. He adds that AFCIs have improved since then. "Somerville – Customer states that smoke detectors go off a lot," pp. 101–102: see Part 8.1. Paraphrased.
 - R1.1 (proving dead, ladders), R1.3 (NM cable and boxes), R1.4 (AFCI and GFCI), R1.12 (remodel triggers), R2.6 and R2.4 (troubleshooting alarms and AFCI trips).
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Videos to watch

These videos are made by other electricians and companies, not YES Electric. Watch each one after you read the section it goes with. Where a video does something differently from this module, the caution line says so. Follow this module and your journeyman, not the video. Click a title to open it on YouTube.

Section	Video
§2.1 Smoke alarm locations (IRC R314.3)	Smoke Alarm Locations: What the Code Requires National Fire Protection Association and FPLSafety Shawn • 3:29 An NFPA instructor walks a floor plan and shows an alarm in each bedroom, one outside each sleeping area, and one on every level including the basement. Caution: He works from NFPA 72 (the 21 ft from bedroom doors rule and the 500 sq ft / 30 ft coverage rule for big floors). Birmingham enforces the IRC, which says 'in the immediate vicinity of the bedrooms'; use the module's R314.3 list.
§2.2 and §2.5 Distance from cooking appliances and mounting position	Smoke Alarm Installation: The Dos and Don't of Smoke Alarm Placement National Fire Protection Association and FPLSafety Shawn • 4:57 The same NFPA instructor shows ceiling vs wall mounting (top of alarm within 12 in of the ceiling) and the keep-away distances from ranges, bathroom doors, supply registers, and ceiling fan blades. Caution: He gives the NFPA 72 cooking zones (20 ft, 10 ft, 6 ft) in a different way than the module's IRC R314.3.1 table by alarm type; use the module's table. The 36 in from registers and fan blades is NFPA 72 placement guidance, which matches the module's 'works poorly' list.
§4.2 and §4.3 Cable, boxes, and wiring each alarm (new work)	How To Install Smoke Detectors And Carbon Monoxide Detectors - CODES EXPLAINED! The Excellent Laborer • 10:52 On an open-framed new house he runs 14-2 to the first alarm and 14-3 between alarms, then joins the harness black, white, and red to the cable conductors with wire nuts in each box and mounts the brackets. Caution: He is an owner-builder, not an electrician. His CO rules ('a combo in each hallway and on each level') are his local code; Birmingham follows IRC R315 as written in the module. He tucks the grounds back unconnected because the alarm has no ground lead; YES still joins all grounds in the box and bonds a metal box.
§4.3 and §4.4 Wiring each alarm, bracket, battery tab, and test (Kidde)	How to Install a Kidde DETECT Hardwired Smoke or Hardwired Combination Alarm (Full Guide) Kidde Fire Safety • 6:34 Kidde's own install video shows the breaker off, the harness pulled through the bracket, the 'A' line on the bracket, pulling the battery tab before power-on, the twist-lock, the green power light, and how the initiating alarm blinks red. Caution: It skips the actual wire-nut splices ('connect the harness as directed'), so pair it with the Excellent Laborer video. It mentions a Kidde quick-connect adapter for replacements; the module says to cut off the old harness and wire the new one.

§5.1 and §5.2 Wireless interconnect	Kidde Wire-Free Interconnect Alarms – Network Setup Kidde Fire Safety • 3:16 Kidde shows how to pair its current wire-free interconnect alarms on a table before mounting: side button on each unit, pick a host, wait for 'Success, now connected,' and close the network. Caution: This is the newer push-button pairing. The module describes the older RF-SM-ACDC, which uses an 8-position dip switch set to the same random pattern on every unit. Follow the manual for the model in the box.
§6.3 Replacing an old hardwired alarm	How to Replace Hardwired Smoke Detector – Safely Update Your Smoke Detectors with Kidde FireX TheRenderQ • 4:53 A homeowner swaps four Kidde FireX alarms in a rental, replacing the harness one color at a time (black to black, white to white, red to red), mounting the new bracket, and plugging in the new alarm. Caution: He twists the old alarm off before turning off the breaker; YES turns off the breaker and proves dead first (module 6.3 step 4). He checks dead with a non-contact tester only; use live-dead-live with a meter. He pulls the battery tab after power-on; Kidde says pull it before, or the alarm chirps. He does not read date codes or test from the first and last alarm.