Air-sealing Can

Common air-sealing enclosures can lead to

BY LARRY ARMANDA

I've been an electrical contractor and a building-performance professional for more than 35 years. Over the past two decades, I've read countless articles in *Fine Homebuilding* and other magazines that describe the use of enclosures built from drywall and foam insulation to air-seal can lights in attics. Sealing these notoriously leaky fixtures—which waste energy, allow moisture into the attic, and contribute to ice dams—is a good idea. Unfortunately, the way many builders and weatherization professionals approach the work is potentially dangerous. The problem is that heat generated by the lightbulb and trapped within the enclosure can melt the wiring's plastic insulation, leading to arcing and fire.

The author tested seven different bulbs in five air-sealing enclosures.

Air-sealing can lights safely isn't a new concern of mine. I did my first research in 2001 and published the results in *Home Energy,* a magazine for the weatherization industry.

I recently completed new research into the subject. This time I built a more comprehensive test rig that mimicked common ceiling construction, and I tested five types of air-sealing enclosures: three homemade versions (2-in. polystyrene insulation, 1-in. foil-faced polyisocyanurate insulation, and 5⁄8-in. drywall) and two manufactured enclosures (CanCoverIt and Tenmat). In turn, I installed these enclosures over fixtures (with the can light's thermal safety switch bypassed so that I could determine the maximum temperature inside the various enclosures) and taped them to the drywall ceiling with foil tape, similar to how weatherization crews would install them.

Attics add to the problem

Summertime attic temperatures prevent heat within the enclosure from dissipating, which adds to the risk of shorted wiring and fire. To simulate the worst-case scenario, I built a large insulated box over my test-light setup and heated it to 135°F with a 300w lightbulb. (Attics in my part of Pennsylvania routinely get this hot on summer days.) I ran a total of 35, 12-hour tests with seven different lightbulbs in each of the five enclosures. I recorded the temperatures inside the enclosures in three locations and inside my "attic" test space with a four-channel HOBO data logger. What I found is alarming.

The highest temperatures recorded approached 250°F with a standard incandescent bulb. Although this isn't the bulb that these fixtures are designed for, weatherization crews routinely find them in can lights. Even with the correct bulb, though, temperatures inside the boxes routinely exceeded 160°F, high enough to degrade the insulation on older versions of nonmetallic-sheathed (NM) cable, which

AN ACCIDENT WAITING TO HAPPEN

Heat generated by the bulb and trapped within the enclosure can have a dangerous effect on the surrounding materials. There are four potential problems with the way many can lights are air-sealed.

Fixture

Older non-IC can lights don't have a thermal safety switch, so temperatures inside an enclosure can climb until the foam box melts or the insulation on the wires melts or catches fire.

Wiring

Nonmetallic-sheathed cable installed before 1984 is rated for 140°F. Testing reveals that temperatures inside the box can reach 171°F, even with the correct 65w PAR 30 incandescent bulb.

Enclosure

Polystyrene insulation starts to melt at 167°F, yet internal temperatures can exceed 170°F with the correct bulb and approach 250°F when a standard A19 Edison-style bulb is installed.

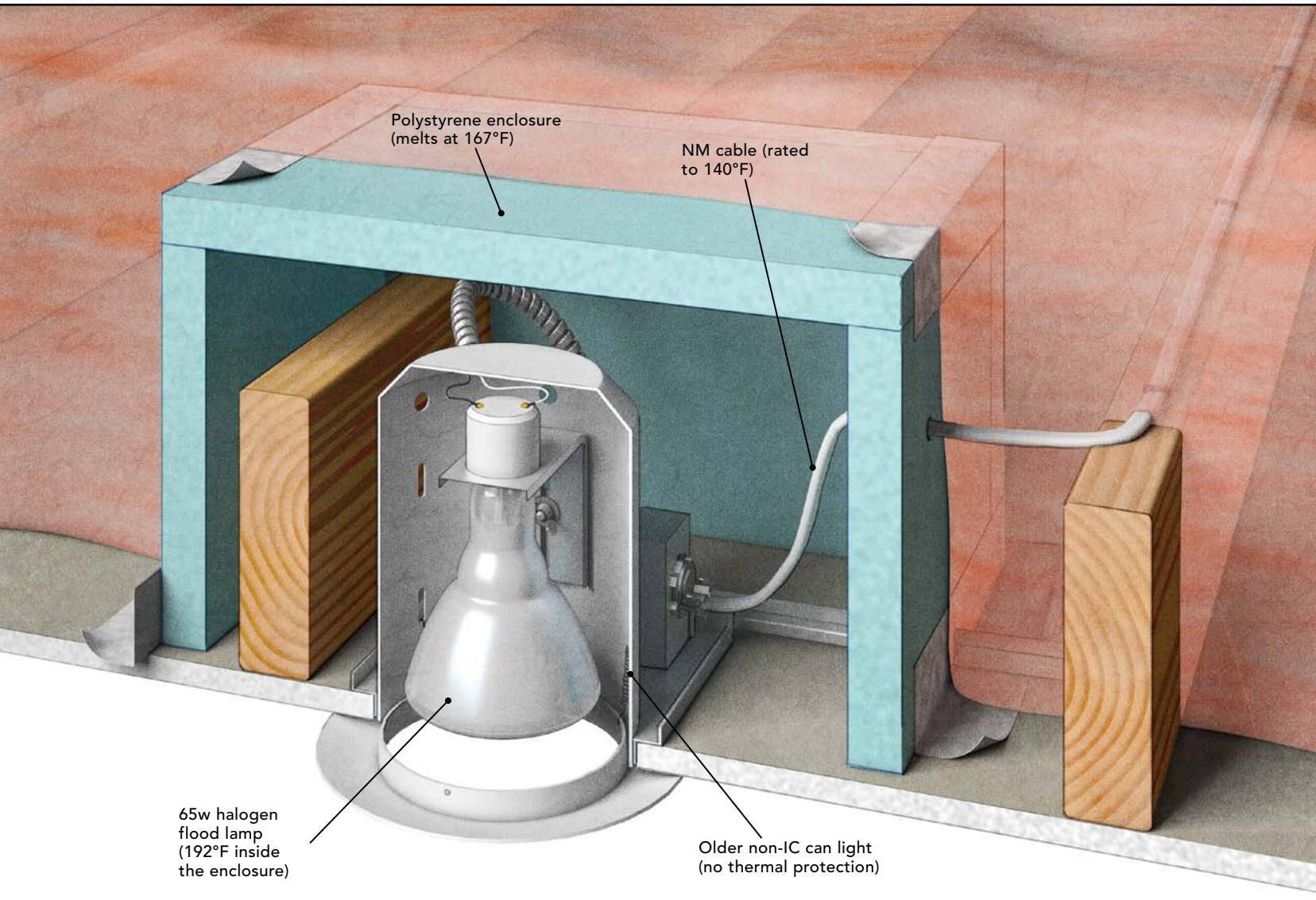
Bulb

Weatherization crews and electricians routinely find the wrong bulbs installed in ceiling-mounted can lights, but even the correct bulb can make the inside of the enclosure over 170°F—too hot for older wiring.

Photos this page: Patrick McCombe. Drawings: John Hartman.

Lights Safely

melted foam, shorted wiring, and even fire



Is your wiring safe?

NM cable This cable is rated to 140°F and was in use from the mid-1960s through the mid-1980s. It looks like modern NM-B cable, so you need to read the sheathing to tell the two apart.

NM-B cable Introduced in 1984, NM-B cable is rated to 194°F. It's the only safe wire for inside can-light enclosures. The NM-B designation is printed or embossed on the cable's sheathing.

EVEN THE RIGHT BULB CAN BE DANGEROUS

75w A19 standard bulb
This Edison-style incandescent bulb generated the highest temperatures inside all five enclosures. It produced 245°F in the polystyrene cover, well above the material's melting point of 167°F. It raised the temperature to 246°F inside the polyisocyanurate and Tenmat enclosures. The CanCoverIt reached 224°F, and the drywall enclosure reached 216°F. All of these temperatures would have tripped the thermal safety switch and easily exceed the rating of NM cable and even modern NM-B cable.

65w PAR 30 halogen flood
This common bulb produced 192°F in the polystyrene, polyisocyanurate, and Tenmat enclosures, which is very close to the point where the fixture's thermal safety switch will activate (194°F), turning off the light. These temperatures also easily exceed the rating of NM cable. The CanCoverIt (183°F) and the drywall enclosure (164°F) were cooler, but still too hot for NM.

65w PAR 30 standard flood
This is the traditional bulb for common can-light fixtures. Even so, the air inside the polyisocyanurate enclosure reached 175°F. The Tenmat was 173°F, and the polystyrene and CanCoverIt reached 167°F, which is very close to polystyrene's melting point. At 156°F, the drywall enclosure was the coolest. All of the enclosures reached temperatures that exceed the temperature rating of NM cable but that are below the activation point of the thermal safety switch.

22w LED lamp
Even though many people think of LEDs as generating little heat, the polyisocyanurate enclosure reached a high temperature of 145°F. The Tenmat was 144°F, and the CanCoverIt was 143°F. All of these temperatures were above the NM-cable rating but well below the point where the thermal safety switch is triggered. The lowest temperatures were recorded with the polystyrene and drywall enclosures, which were 140°F and 134°F, respectively.

13w Utilitec LED trim kit
Of the bulbs tested, this is the safest option. It generated 123°F inside the CanCoverIt, 118°F inside the polyiso enclosure and Tenmat, and 117°F inside the polystyrene. The lowest temperature was recorded inside the drywall enclosure (106°F). All of these temperatures are safe for NM cable and well below the activation point of the thermal safety switch. This kit is rated for 50,000 hours, so it's unlikely that it will be swapped for an incandescent later.

is rated to 140°F. This type of cable was installed from the mid-1960s until 1984.

I also found that foam enclosures could get hot enough to melt when the lights had halogen flood lamps or conventional Edison-base lightbulbs. In some cases, temperatures were above the foam's melting point of 165°F, but not quite hot enough to trip the light's thermal safety switch, which activates at 194°F. This switch is included on modern can lights to prevent overheating.

Older cans don't have a thermal switch, so when they're enclosed, it's conceivable they would keep getting hotter until either the wiring or the enclosure melted. Although I didn't see any melted wires during my comparatively brief periods of testing, I've seen NM cable that's exposed to long-term heat from early fluorescent ballasts: The inner insulation gets brittle and melts, leading to shorts and electrical fire. I did, however, see evidence of localized melting in the extruded-polystyrene enclosure I built. This enclosure was in service only for 12 hours at a time. You can imagine what might happen if the light was left on with the wrong bulb for a few days or more.

Building a safe enclosure

Given the problems with conventional methods of air-sealing can lights, I've come up with what I consider the safest way to do it. For starters, I recommend a manufactured Tenmat enclosure (tenmat-us.com), which is made from mineral wool and is fire resistant. You also can use drywall enclosures. They sufficiently resist heat, although they are more susceptible to mold growth in homes with high humidity because the paper facing is a good food source for mold.

Make sure the wiring that supplies the can light is designated NM-B (see "Is your wiring safe?" p. 57), which is rated to 194°F. If the wiring is not NM-B, install a junction box about 18 in. away from the fixture, and use a short length of modern NM-B to connect the older wire and the fixture. Put the junction box on a mast so that it's not buried in insulation and is easy to find for any future work. Finally, use high-quality UL-181 foil duct tape or a fireblock-type spray foam to seal the enclosure to the drywall ceiling.

Choose the right bulbs

I found that you can keep the fixture sufficiently cool and safe by using the correct reflector bulbs. Unfortunately, the right bulb is often replaced with an Edison-style or halogen reflector bulb when the correct bulb burns out. The best way to prevent the installation of the wrong bulb is to install an LED can-light conversion kit. These conversion kits ($25 to $35) have life spans of about 50,000 hours (almost four years of nonstop use), making it unlikely that someone will swap one out for a potentially dangerous incandescent light.

Many of these retrofit kits claim to be airtight, so you might be tempted to install one and forget the can-light enclosure altogether. Unfortunately, when researchers tested supposedly airtight kits in the past, they found that most were improperly installed, reducing their effectiveness. I don't know of any research that's been done to confirm the airtightness of modern LED retrofit kits. Until we know for sure, I think appropriately constructed can-light enclosures are still the best solution, short of removing the can lights altogether. □

Larry Armanda is a building-science trainer and consultant. His company, Therma View Energy Consultants, is in Williamsport, Pa. Photos by Dan Thornton, except where noted.

FOUR FACTORS THAT MAKE A SAFE ENCLOSURE

Fixture

Modern can lights have a thermal switch that turns off the fixture when the temperature reaches 194°F. It's an important safety device, but it's set too high to protect older wire from the heat trapped within the enclosure. Older can lights often don't have this safety feature, so they should be replaced with modern versions before any air-sealing occurs.

Enclosure

Made from mineral wool, the Tenmat enclosure won't melt like polystyrene insulation, and the larger version (model FF135) is big enough to maintain the code-required 3-in. clearance to the fixture even when there's a joist nearby. The Tenmat cuts easily with scissors for fitting it around cables and the mounting hardware.

Wiring

Modern nonmetallic-sheathed cable identified as NM-B is rated for 194°F. Testing reveals that temperatures inside the box reach 171°F with the correct 65w PAR 30 incandescent bulb, but modern cable won't be enough if somebody installs the wrong bulb, which can bring temperatures inside the enclosure to 246°F.

Bulb

Even if you take all of the other steps described here to protect the wiring from damage and use a heat-resistant drywall or Tenmat enclosure, the wiring is still at risk if somebody installs the wrong bulb. The best way to prevent this is to install an LED can-light conversion kit, which is dimmable, has good color rendition, and should last for 50,000 hours.