The Pennsylvania Housing Research/Resource Center

Air Leakage in Recessed Lighting

Builder Brief BB0502

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Introduction

They have many names; top hats, can lights, pot lights, down-lights and recessed lights. Whatever you call them, no other type of artificial lighting offers more versatility for residential construction than recessed cans.

There are literally hundreds of options or products available to meet a variety of general or accent lighting needs. This Builder Brief highlights some issues concerning the impact of recessed cans on residential energy use and the integrity of the building enclosure, notably with regards to air leakage and potential moisture problems. Some guidance for the builder/remodeler based on recent research, issues of code interpretation, and available product types is offered.

Any penetration that allows conditioned air to leak into unconditioned spaces, such as ceiling or attic cavities, contributes to the air leakage rate of a house. Air leakage is undesirable because it increases fuel bills, causes discomfort, and leads to moisture problems, which, in turn, may lead to builder call-backs. The large rough openings needed to install recessed cans and the numerous perforations in the housing assemblies and trims make them extremely susceptible to air leakage if left improperly sealed from the conditioned space.

The integrity of the building itself may be compromised if moisture-laden warm air leaking through these assemblies comes into contact with cold surfaces within unconditioned spaces or cavities. Condensation and mold growth may result. In addition, roof sheathing may be sufficiently warmed to contribute to the creation of destructive ice damming.

Recessed lighting is here to stay. If installed incorrectly they may contribute to air leakage and compromise building integrity.

By their very nature, standard IC or non-IC housing and trim packages are very leaky. **Non- IC** fixtures are designed for Non-Insulated Ceilings. **IC** fixtures may be in contact with insulation. These conventional types exist in millions of homes. In middle to upper end homes the numbers of can lights may range from twenty to forty per home. Can lights are typically installed in high activity areas such as eat-in kitchens, hallways, and family rooms. They are also a very popular lighting application in those rooms with either high or cathedral ceilings.

When located in the upper stories of a building enclosure, recessed cans may contribute significantly to stack effect. Picture a home as a short, fat chimney. When warm air rises as a

function of a temperature difference between the inside and outside of a home, a pressure difference is created across openings (recessed cans) at the top of the house. The taller the house, the greater the driving force. The more openings there are, the greater the resulting air flow into and out of the house.

From 1997 to the present, PHRC staff at Penn College have documented hundreds of instances of can light leakage, through its Act 222 inspection program of new homes in PA. As part of the inspection protocol, blower door testing, done in conjunction with infrared imaging, has revealed that out of all the possible air leakage sites in a house, can lights are responsible for the worst leakage.

The snowmelt pattern on this roof was due to air loss around a recessed can light fixture (which was not in use) mounted in a cathedral ceiling

In one case, while responding to a call by an electric utility on behalf of a customer with an unusually high winter fuel bill, investigators observed a high leakage rate for the house and attributed much of it to the 134 unsealed recessed cans in the home. The winter of 1996 was a particularly snowy winter for North Central PA. On this particular home ice dams were present in roof assemblies containing multiple recessed cans. On the north side of the home an ice dam about the size of a minivan broke away from the eaves and flattened two large AC compressors on the ground below. That's a pretty expensive air leak.

How much of an impact do recessed cans have on the total air leakage picture of a house? It is estimated that one conventional (IC or non-IC) fixture can be responsible for the loss of between $5 and $30 per year worth of energy and can dump about one-third of a gallon of water daily into a cold attic. These estimates are based on actual measurements performed by the Mechanical Engineering Department at Penn State University in conjunction with Juno Lighting Inc. The tests were designed to assess the benefits of the new airtight fixtures on the market at the time of the study (1992).

Meeting the Code

Builders have to come to grips with the air leakage as a result of problems associated with recessed cans. With the enactment of the Uniform Construction Code (UCC) in Pennsylvania, the state will adopt the IRC 2000 of which Chapter 11 (or a PA Alternative) deals with energy efficiency. Chapter 11 contains specific language (section N1101.3.2.2) as to how air leakage sites are to be sealed.

For those homes that exceed 15% glazing-to-wall-area ratio, builders will be required to comply with the 2000 International Energy Conservation Code (IECC). With regards to recessed lighting fixtures, section 502.1.3 of the IECC specifies prescriptive design and installation criteria for recessed lighting as one of the following:

1. *Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.*
2. *Type IC or non-IC rated, installed inside a sealed box constructed from a minimum 0.5 inch-thick gypsum wall*

board or constructed from a preformed polymeric vapor barrier, or other air-tight assembly manufactured for this purpose, while maintaining proper clearances of not less than 0.5 inch from combustible material and not less than 3 inches from insulation material.

Given the number of recessed cans in a typical new residence, constructing gypsum wall-board boxes on site as the code suggests and creating an effective seal would likely be an expensive proposition for builders and remodelers. The lighting industry has recognized the challenge and devised a solution

Enter the "AirTight" Recessed Can

Within the past ten years, most major lighting manufacturers have made a number of different types of housing and trim packages available, sold under trademark names such as "Air-tite, "Air-Loc" and Air Seal".

The state of Washington provided the initial incentive in 1992. The state revised its code to require that all recessed ceiling fixtures meet strict air tightness requirements to reduce energy loss and to limit moisture transfer through the fixtures into interstitial building cavities. To qualify under the 1992 code change, fixtures had to restrict measured air leakage to less than 2 cfm air flow at 75 Pascals pressure difference (tested according to ASTM E-283 test method).

By comparison, measured air leakage rates for conventional fixtures vary from less than 10 cfm to over 30cfm at 75 Pascals. Many manufacturers now refer to their own products that meet the 1992 air tightness criteria as "Washington State compliant".

A popular brand of airtight recessed can with the airtight enclosure in a raised position. These fixtures should also provide a type of gasket or seal between the fixture and the inside of the ceiling

One manufacturer produces a trim package that, when combined with a gasketed housing and enclosure, is designed to effectively isolate the whole recessed can assembly from the living space. A fixture such as this would be classified as "IC Air Tight". The critical question is this: At a considerably higher cost than conventional fixtures, do they really work?

It seems that the only products that can provide a truly effective seal are those products with a pre-installed gasket between the fixture and the inside of the ceiling or those where the trim forms a tight seal to the inside of the fixture and ceiling. The enclosure itself should also be airtight. Tub and shower trims may also be quite effective in that they form a continuous seal by incorporating a clear lens and gasket. Most manufacturers offer a wide variety of tub and shower trim styles. A word of caution here: "overlamping" or installing a bulb greater than the rated wattage on these fixtures may result in excessive heat build up behind the lens. Consequently, the built-in thermal switch will most likely cause the lamp to cycle off. Additionally, using tub and shower trims may not meet general or accent lighting needs.

Cost Comparisons

Costs associated with airtight fixtures may cause some sticker shock for builders and homeowners. A conventional IC rated housing and trim package (each sold separately) runs around $24. Contractor prices for airtight fixtures on the other hand range from $32 to over $60 depending on the manufacturer. This does not include installation cost.

A Word of Caution to Remodelers

A temperature profiling experiment was recently performed at the Weatherization Training Center at Penn College. Its purpose was to record temperatures of recessed can light fixtures, using different lamps, before and after enclosing a fixture in an airtight box at different ambient air temperatures. It was concluded that as long as a properly rated bulb was installed in the fixture, temperatures remained within acceptable limits (90°C/ 194°F) for NEC code compliant type NM-B (Non-metallic sheath) wire.

Remodelers need to be cautious, however. Preset thermal cutouts integrated into modern light fixtures are compatible with 90°C NEC standards. Wiring manufactured prior to 1984, without the B suffix is rated at 60°C. This type of wiring is found in most older homes built prior to 1982.

In conclusion issues concerning the cost of space conditioning, the code, building integrity and customer satisfaction, should cause homeowners, builders and remodelers to consider lighting options that include airtight features.

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