

# Energy Design Update<sup>®</sup>

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## **Air and Moisture Leakage Through Recessed Ceiling Light Fixtures**

One conventional recessed ceiling light fixture loses between \$5 and \$30 per year worth of energy, and dumps about one-third gallon of condensed moisture daily into a cold (32°F) attic. These estimates are based on actual measurements performed at Pennsylvania State University in cooperation with Juno Lighting, Inc. The tests were designed to assess the benefits of the new airtight recessed ceiling light fixtures now sold by Juno and other fixture manufacturers.

Recessed ceiling light fixtures have long been recognized as a potentially serious flaw in ceiling air barrier systems. In 1992, the state of Washington revised its building code to require that all recessed ceiling fixtures meet strict air tightness requirements (see *EDU*, February 1992). Although energy loss was a consideration, the primary reason for the Washington requirement was to limit moisture transfer from humid indoor air up into cold attics.

### **Measured air leakage from 2 to 10 cubic feet per minute per fixture**

The Penn State tests, performed by Susan Bennett and Horacio Perez-Blanco in the Department of Mechanical Engineering, show that air leakage through a recessed fixture varies from about 2 to 10 cubic feet per minute (cfm), depending on the degree of "stack pressure" against the ceiling.

Bennett built a test apparatus that simulates a ceiling with a single, conventional (Juno brand) recessed light fixture. They measured the air leakage through the fixture under various pressure differentials ranging from 0 to 3 pascals (Pa). (In a single-story home in winter, the stack pressure across the ceiling is typically between 1 and 5 Pa.) With a 100-watt lamp, the measured air leakage varied from 2.3 cfm at 0.5 Pa pressure to 9.7 cfm at 3 Pa pressure.

### **Nine gallons of moisture per fixture per month into the attic**

Indoor air at 70°F and 40% relative humidity contains 0.000055 gallons of moisture per cubic foot of air -- a seemingly tiny amount. And when leaked into an attic at 32°F, less than half of that moisture will theoretically condense into liquid water -- 0.000021 gallons per cubic foot of air. But with 10 cfm continuous air leakage, the total condensation adds up to about 0.3 gallons per day or 9 gallons per month. And that is for just one fixture. In a house with 20 recessed light fixtures, the total calculated moisture load into the attic would be 180 gallons per month.

### **One-year payback from energy savings with airtight fixtures**

If the air leakage were 10 cfm per fixture during the entire heating season, the total energy penalty would be about 1.3 million Btu per fixture -- about \$10 per year with 80% efficient gas heating at average gas price (\$.60/ccf).

According to Charles Huber, vice president of corporate development at Juno Lighting, Inc., the extra cost to the consumer for Juno's "Air-Loc" lighting fixtures, compared to non-airtight fixtures, is about \$5. At that premium, the payback period from energy savings is one year or less.

### **Laboratory results vs. the real world**

Given the variability in real homes, these moisture and energy calculations may vary 100% or more from real situations. For example, a study performed by Ecotope, Inc. of Seattle estimated that actual air leakage through recessed fixtures is about 5 cfm and that the total energy cost penalty for a typical house in the US Midwest is about \$5 per year. Nonetheless, even with that degree of error, the results definitely indicate that nonairtight fixtures can cause moisture problems in attics and that replacement with airtight fixtures should not only reduce moisture problems, but will also save enough energy to pay for their small extra cost.

### **Interesting side note -- wattage not important**

One interesting observation in the Penn State results is that the wattage of the lamp had little effect on air leakage. One would expect that a hot 100-watt incandescent lamp would pull more air up through the fixture by the "chimney effect" than a cooler 13-watt compact fluorescent lamp. Not so, according to the Penn State data, which showed that a 100-watt lamp, with 275°F fixture temperature, allowed an almost identical air leakage rate as a 13-watt compact fluorescent with only 95°F fixture temperature.

### **Available airtight fixtures and more information**

All the manufacturers listed below sell airtight fixtures that meet the rigorous Washington State code requirements. However, the fixtures are not all widely distributed or promoted outside Washington. One exception is Juno Lighting, Inc., which is aggressively promoting its new "Air-Loc" fixtures.

Charles Huber, Juno Lighting, Inc., 2001 S. Mt. Prospect Road, P.O. Box 5065, Des Plaines, IL 60017-5065; (800) 323-5068.

Fred Madl, Halo Lighting, 400 Busse Road, Elk Grove Village, IL 60007; (800) 222-2018, (708) 956-8400, or (800) 323-8705.

Joe Manning, Lightolier, 100 Lighting Way, Secaucus, NJ 07096; (800) 223-0726.

John Taylor, Prescolite Lighting, 1208 Tappan Circle, Carrollton, TX 75006; (800) 346-6377 or (510) 562-3500.

For more information on the Penn State study, contact Susan Bennett or Horacio Perez-Blanco, The Pennsylvania State University, College of Engineering, Department of Mechanical Engineering, University Park, PA 16802; (814) 865-0925 or 7842; Fax: (814) 863-4848.

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