

COSTS AND BENEFITS OF  
RADON-RESISTANT NEW CONSTRUCTION

The City of Fort Collins will soon decide whether to require radon-resistant new construction (RRNC) for single-family units as part of the Building Code. It is important to keep some questions in mind. What happens if we do nothing, i.e., leave things as they are? What are the benefits and costs of requiring a passive radon reduction system? What if an active system were required? Calculation details follow the narrative.

What happens if we do nothing?

About 14,400 single-family dwelling units would be built in the Fort Collins Growth Management Area before we run out of land. About 9,600 multi-family units would also be built, but they would not be covered by the current proposal. About 35,300 people would live in those homes. Radon exposure inside these homes would be about 3.0 pCi/L, which is the average of long-term, first-floor measurements in Fort Collins homes. Each new home is assumed to have about the same useful life as a person's lifespan, about 75 years. The above radon exposure over the homes' lifetime would result in about 311 lung cancer cases. USEPA reports that cancer risk estimates are uncertain by about a factor of two, so the expected number of cancer cases if we do nothing would lie in the range of about 150 to 600. If the City "does nothing," the cancer risk would still be reduced somewhat by voluntary installation of RRNC and by voluntary mitigation of homes after construction, but these are not included in the cost-benefit calculation.

What are the benefits and costs of requiring a **PASSIVE** radon reduction system?

Adding a passive system to each new home would reduce radon exposure by about 47%, with a consequent reduction in cancer cases of about 146. It would cost about \$14.4 million to add passive systems to 14,400 new homes. It would therefore cost about \$99,000 to avoid one case of lung cancer (range \$50,000 to \$200,000).

What are the benefits and costs of requiring an **ACTIVE** radon reduction system?

An active system includes all the components of the passive system plus a fan. Adding an active system to each new home would reduce radon exposure to near-background level, or about 87% total reduction, with a consequent reduction in cancer cases of about 270. It would cost about \$86 million to add active systems to 14,400 new homes, and to operate and maintain them for 75 years. It would therefore cost about \$317,000 to avoid one case of lung cancer (range \$150,000 to \$600,000).

City of Fort Collins, Natural Resources Department  
January 28, 2004

Calculation details

Formula symbol	Definition	Data	Data source or formula
<b>NO RADON REDUCTION SYSTEM</b>			
Units	Number of new single-family dwelling units to be built	14,400	City of Fort Collins, Advance Planning
Occupancy	Occupants per dwelling unit	2.45	2000 Census
People	Number of people benefiting from lifetime radon reduction	35,300	Units x Occupancy
Annual Rate	Larimer County age-adjusted lung cancer rate, deaths/year	Males: 51.4 Females: 27.9	PHSD <sup>1</sup>
Life-years	Life expectancy, years	Males: 75.2 Females: 77.7	PHSD <sup>1</sup>
Lifetime Baseline Risk	Lifetime lung cancer risk from all sources, per 100,000 population	Males: 3865 Females: 2168	Annual Rate x Life-years
Radon Fraction	Fraction of lung cancers attributable to radon, per pCi/L	Males: 9.45% Females: 10.28%	BEIR VI <sup>2</sup>
Radon Risk	Lifetime lung cancer risk from radon exposure, per 100,000 population, per pCi/L	Males: 365 Females: 223 Both: 294	Lifetime Baseline Risk x Radon Fraction
Exposure	Average radon exposure	3.0 pCi/L	Borak <sup>3</sup>
Expected	Number of cancer cases expected without mitigation	311	People/100,000 x Radon Risk x Exposure
<b>PASSIVE RADON REDUCTION SYSTEM</b>			
Reduction	Avg. radon reduction achieved by passive system	0.47 (47%)	Kladder <sup>4</sup> , citing three studies
Passive-avoided	Number of cancer cases avoided by passive systems	146	Expected x Reduction
Passive-cost	Avg. cost of passive system	\$1,000	City of Fort Collins <sup>5</sup>
Passive-total	Total cost of passive systems installed	\$14.4 million	Units x Passive-cost
	Cost per cancer avoided with passive radon reduction systems	\$99,000	Passive-total / Passive-avoided
<b>ACTIVE RADON REDUCTION SYSTEM (passive + fan)</b>			
Background	Avg. radon level achieved by active system	0.4 pCi/L	Assumption: same as outdoor background, or about 87% total reduction
Active-avoided	Number of cancer cases avoided by active systems	270	People/100,000 x Radon Risk x (Exposure – Background)
Active-cost	Avg. cost of active system	\$1,300	\$1,000 + \$300 <sup>5</sup>
Operating	Annual cost to operate & maintain active system	\$62	Electricity: \$32/year <sup>6</sup> Maintenance: \$30/year <sup>7</sup>
Active-total	Total cost of active systems installation and operation	\$86 million	Units x [Active-cost + (Operating x 75 years)]
	Cost per cancer avoided with active radon reduction systems	\$317,000	Active-total / Active-avoided

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<sup>1</sup> Bruce Cooper, Poudre Health Services District, personal communication

<sup>2</sup> David Pawel, US Environmental Protection Agency, personal communication, based on Health Effects of Exposure to Radon: BEIR VI, Board on Life Sciences, National Academy of Sciences, 1999. The risk per pCi/L is calculated by dividing the geometric mean of two preferred risk models (page 96) by 1.25, the national average indoor radon level.

<sup>3</sup> Borak, T.B., et al.; A Survey of Winter, Summer, and Annual Average Rn-222 Concentrations in Family Dwellings, Health Physics Vol. 57, No. 3 (September), pp. 465-470, 1989. The average of first-floor, 12-month tests in a study of 100 Fort Collins homes is 3.0 pCi/L.

<sup>4</sup> Kladder, D.L.; Proposal for the Addition of Radon Resistant Construction Techniques to the Appendix Of the Uniform Building Code – Supplemental Information, submitted to the International Conference of Building Officials, 1996

<sup>5</sup> City of Fort Collins estimate, based on current market conditions

<sup>6</sup> Electricity assumptions: 60 watt fan operated continuously @ 6 cents per kilowatt hour.

<sup>7</sup> Maintenance assumptions: fan must be replaced every 8 years @ \$243 per replacement for labor and materials.