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Other Research

Design Wins EPA/AEE Award

Efficiency, Air Quality Can Work Synergistically

Mike Nuess, a program supervisor at the Washington State Energy Office's Energy Extension Service in Spokane, has won the 1991 Innovative Radon Mitigation Practical Design Competition sponsored by the U.S. Environmental Protection Agency (EPA) and the Association of Energy Engineers (AEE).

Nuess, who won for a home he built in 1988, said it is an example that "energy efficiency and indoor air quality are not only potentially compatible, they may actually be synergistically woven together."

"In this house," he said, "the tight envelope and the continuous mechanical ventilation system are key to the synergy that provides high levels of energy efficiency as well as pressure differences to control radon entry."

"A continuous 1-year radon measurement indicated an average indoor radon level of 26 Bq/m³ (0.7 pCi/L)."

The design also won the 1991 Design Competition Award from the Energy Efficient Building Association at the University of Southern Maine's Technology Center in Gorham, Maine.

An essential ingredient of the design's objective, Nuess said, was that it be broadly applicable to new residential construction in the United States.

The following is a description from the EPA of radon control performance for the home, which cost $80,824, approximately $45 to $48 per square foot.

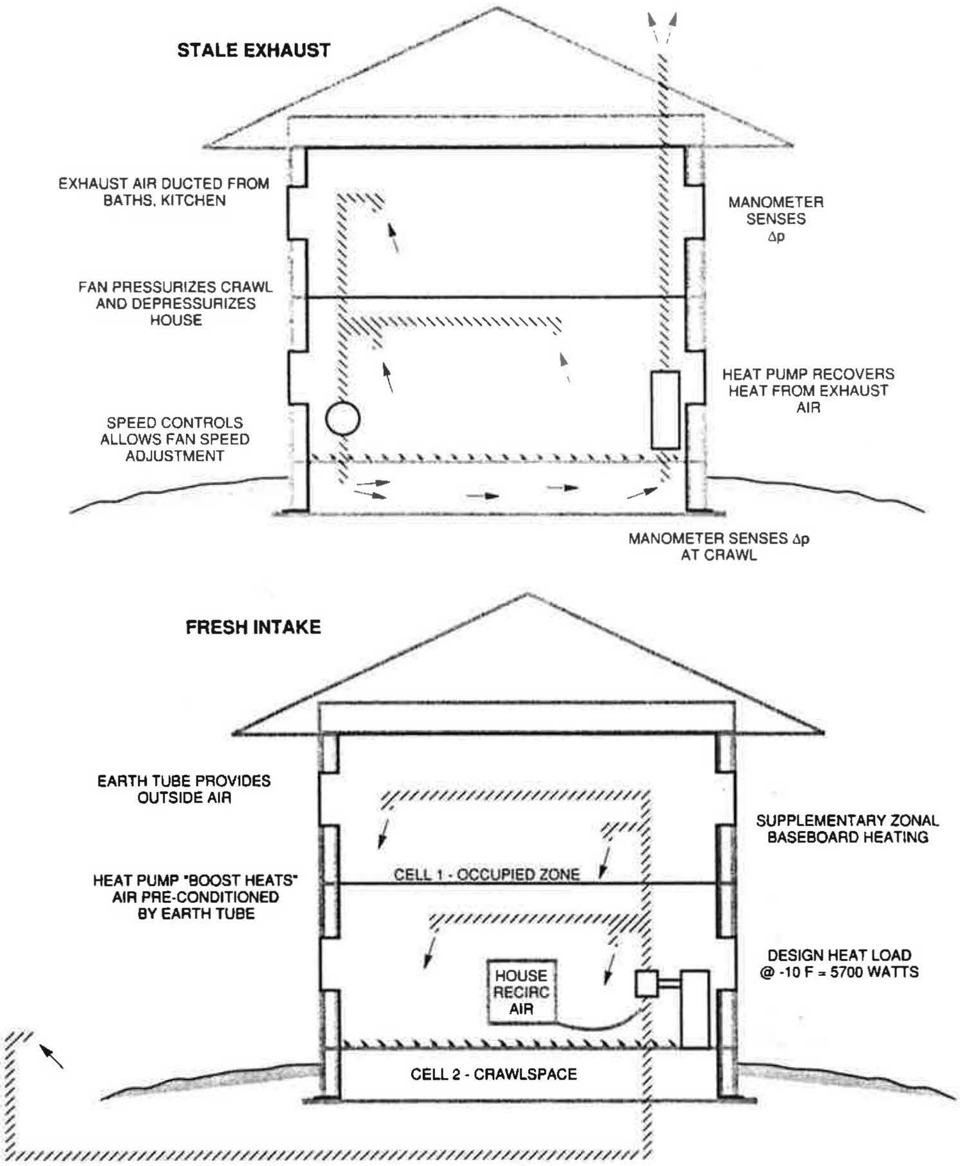
Radon control seems to have been readily achieved by the designed pressure-differences resulting from normal operation of the commercially available continuous mechanical ventilation system. A continuous 1-year radon measurement (alpha track monitor) indicated an average indoor radon level of 26 Bq/m³ (0.7 pCi/L) in the occupied zone.

Also, continuous hourly radon data were recorded at four locations in this building for a 3-month period. Deliberately induced pressure changes, resulting from experimental changes in the ventilation system's fan configuration, had predictable and powerful effects on radon levels.

Weather effects seemed to have no measurable impacts on the indoor radon levels, presumably because of the tightness of the building and the overriding influence of the continuous ventilation system. Experimental manipulations of the radon control system consistently produced crawlspace plenum radon levels of up to 4440 Bq/m³ (120 pCi/L) and consistently returned radon concentrations to baseline levels when readjusted.

Utility billing data exists for 23 months since occupancy of the building began in January of 1989. The zonal electric-resistance space-heating system in this 1800-ft² home was separately submetered. In one year it consumed 2511 kWh ($120) of electricity. The continuous mechanical ventilation system provided efficient heat recovery via a small heat pump. It is estimated to have provided 44% of the space heating need. This brings the total cost of space heating to $216 a year. The measured average annual kilowatt-hour consumption for heating conventional homes in the Northwest is 12,420 kWh, which amounts to $596 at $0.048/kWh.

The normal operation of a commercially available continuous mechanical ventilation system incorporated into a relatively airtight house, and designed to control pressure differences provides sufficient day-to-day control of those pressure differences (induced by weather and mechanical systems) to sufficiently limit entry of radon and other soil-air pollutants. A small (5000 to 7000 Btu/h) commercially available integrated residential heat recovery ventilation system (HRV) provides continuous ventilation, partial space heating, space cooling, and water heating, as well as the desired pressure differences.



WINTER OPERATING CONDITIONS

Fig. 1. Mike Nuess' award-winning house design controls radon by utilizing pressure differences.

Cells 1 and 2 (see Fig. 1) are isolated from each other, from the outside air and from the indoor air by accessible and maintainable air barriers. Sealed ducts allow controlled air passage. Continuous mechanical ventilation removes stale air from cell 1 and delivers it outside via cell 2. Depending on which fans are selected to operate, cell 2 can be either pressurized or depressurized relative to cell 1 and/or the soil-air. This project incorporated four fans in the ventilation system to enable comparison between these two approaches, as well as with other ventilation and pressure-difference configurations (see Fig. 1).

After the building was occupied, the Bonneville Power Administration and the Washington State Energy Office began extensive energy performance monitoring. Once these data are analyzed, a more complete energy performance picture will become available. ▲

Information provided by EPA and Mike Nuess.