Innovative Approach for Radon Control

Dade W. Moeller Ph.D., CHP
Jackson Ellis, CHP

Dade Moeller & Associates, Inc.

Background

- Due to the increasing demand for electricity, and the need to reduce the discharges of greenhouse gases, U.S. nuclear utilities have increased the output of their electric generating plants and have announced plans for constructing new units.
- These utilities can benefit from enhancing their relationships with population groups adjacent to their existing plants or proposed sites for new plants.
- The radon reduction program described here will provide the nuclear utilities a unique opportunity to accomplish this objective.

Why Radon?

- There are two reasons for the emphasis on radon:
  - it is the single largest source of radiation exposure to the U.S. public.
  - it is one that can be readily reduced at reasonable cost.
- Comparing radon to man-made causes of exposure serves as an excellent educational vehicle to help the public gain a better appreciation of the relative significance of the sources of radiation exposures in their lives

Radon Reduction Methods

- The method commonly recommended by the U.S. Environmental Protection Agency (EPA) for the control of radon in homes is to install an *active subslab basement suction system*.
- Such a system is designed to remove radon from the soil so it cannot seep into the home.
- Installation cost per home of about $1,200, and reduces the dose to residents by an average of more than 90%.

Radon Reduction Methods, cont

- For homes without a basement, an effective method for reducing airborne radon decay products is the installation of ceiling fans.
- Constant movement of the air causes radon particulates to “plate out,” thereby not being respirable.
- Installation cost per home of about $1,000 to $2,000 and reduces the dose to residents by an average of about 50%.

Radon Dose Assessment

- UNSCEAR suggests that, in estimating the associated doses, the following factors be applied:
  - An indoor radon decay product equilibrium factor of 0.4
  - A dose coefficient factor of 9 nSv $(Bq\ h\ m^{-3})^{-1}$; and
  - An *indoor* occupancy factor of 0.8

- UNSCEAR reports that the average radon concentration in homes in the U.S. is ~46 Bq per cubic meter.

- To account for the time that people spend indoors, *but not in their homes*, an occupancy factor of 0.6 (5,260 hours per year) will be used in the calculations that follow.

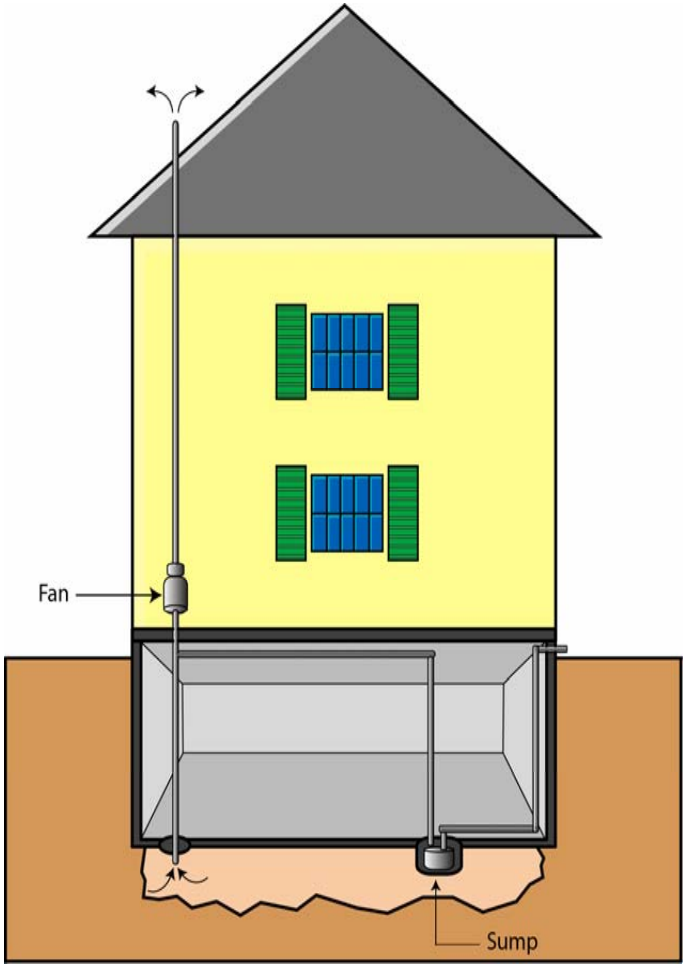
Dose Reduction With Basements

- Assuming a 90% reduction in radon concentration, the estimated reduction in the dose rate due to the installation of an *active subslab basement suction system*, would be:

  [46 Bq m^{-3}] [0.40] [5260 h y^{-1}] [9 nSv (Bq h m^{-3})$^{-1}$] [0.9]
  = 0.78 mSv y^{-1}

- Assuming that the average home is occupied by a 5-person family, this would yield a collective dose rate reduction of:

  [0.78 mSv y^{-1}] [5 persons]
  = 3.9 person mSv y^{-1}



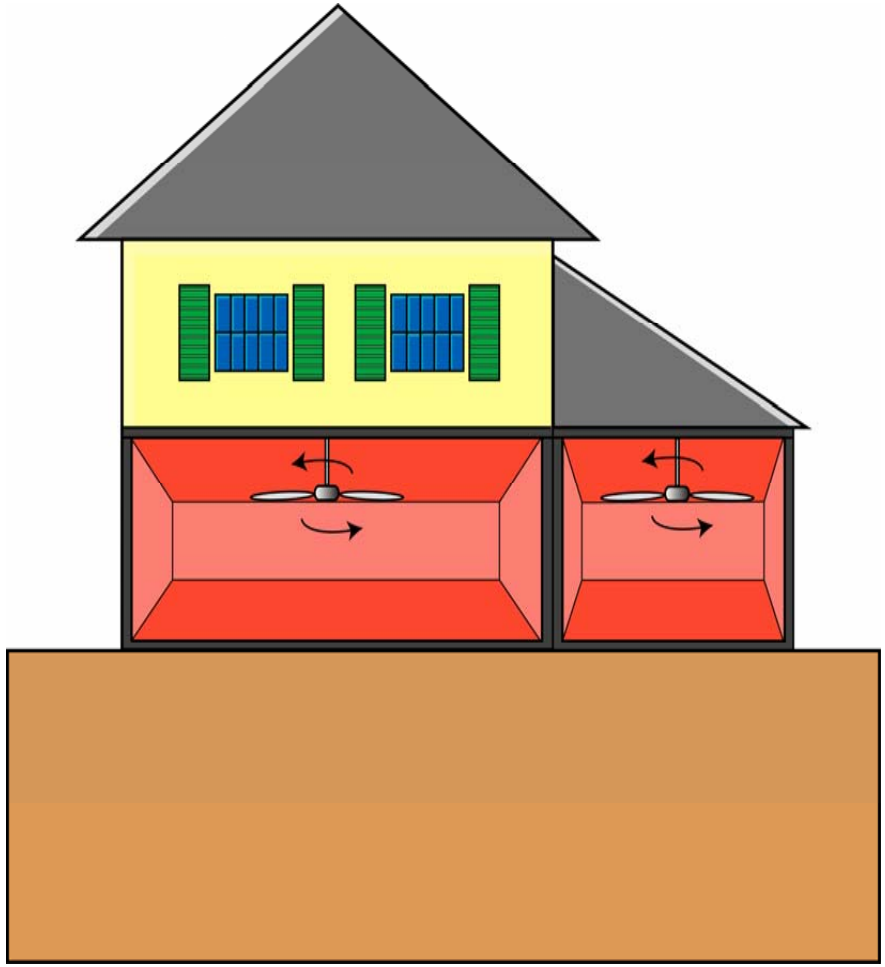
Homes Without Basements

- Assuming that ceiling fans are installed, and that they will reduce the dose rate by 50%, the average dose rate reductions in U.S. homes without basements would be:

  [46 Bq m^{-3}] [0.40] [5260 h y^{-1}
  [9 nSv(Bq h m-3)$^{-1}$] [0.5]
  = 0.44 mSv y^{-1}

- Assuming, once again, that the average home is occupied by a 5-person family, this would yield an estimated collective dose rate reduction of:

  [0.44 mSv y^{-1}] [5 persons]
  = 2.2 person mSv y^{-1}



Population Dose

Data from U.S. Nuclear Regulatory Commission (USNRC, 1996)

- The most recent annual average collective dose to the population within 50 miles of a commercial nuclear power plant in the U.S. was about:

750 person-mrem (7.5 person-mSv)

Population Dose, cont'd

- Homes With Basements

  (7.5 person-mSv) ÷ (3.9 person-mSv) = <2

  Remediation of less than 2 homes would equal the collective dose to the population, residing within 50 miles (80 km), due to radionuclide releases from a typical commercial nuclear power plant in the United States.

- Homes Without Basements

  (7.5 person-mSv) ÷ (2.2 person-mSv)= <4

  Remediation of less than 4 homes would equal the collective dose to the population, residing within 50 miles (80 km), due to radionuclide releases from a typical commercial nuclear power plant in the United States.

Occupational Dose

Data from USNRC (2005b): the average annual collective dose to workers in 2004 at each of the commercial nuclear power plants in the U.S. was 100 person-rem (1,000 person-mSv).

- Homes With Basements

  Remediation of about 260 homes [(1,000 person-mSv) ÷ (3.9 person-mSv)] with basements would equal the collective dose to the workers at a commercial nuclear power plant population in the United States.

- Homes Without Basements

  Remediation of about 460 homes [(1,000 person-mSv) ÷ (2.2 person-mSv)] without basements would equal the collective dose to the workers at a typical commercial nuclear power plant population in the United States.

Table 1

Required number of houses to remediate that will offset the dose resulting from the operation of an average commercial nuclear power plant in the United States

	Average collective dose per plant(a)	Dose reduction per remediated house (a)		Required number of houses to be remediated	
		With basement	Without basement	With basement	Without basement
Population	7.5	3.9	2.2	<2.0	<4.0
Occupational	1,000.00			~260.0	~460.0

(a) All doses are expressed in units of person-mSv/y

Cooperation with EPA

- The Environmental Protection Agency (EPA) has encouraged the development of joint efforts with industry in helping to protect the environment.
  - *Energy Star* program - industries are encouraged to design and manufacture household appliances (for example, refrigerators, washing machines, and computers) that are more energy efficient
  - *Tradable Emissions* program - EPA provides industries the flexibility of reducing airborne releases of oxides of nitrogen and sulfur at minimum cost

Conclusions

- This proposal would extend these activities to include a cooperative EPA-nuclear industry program for the reduction of doses due to indoor radon.
- Implementation of such an approach would not only enhance community relationships but also would demonstrate the commitment of the nuclear industry to maintaining dose rates to the public ALARA, regardless of the source.

Conclusions, continued

- Another possible method for implementing this approach would be for the utility to pay for the costs of installing radon control systems in selected nearby public schools and day care centers.

- It would also be exactly the type of effort that would fit into the EPA “Partners for the Environment” effort, since, one of the activities proposed as part of this program is to monitor and improve the quality of the air in our public schools.

Jackson Ellis, CHP

jellis@moellerinc.com

Dade Moeller & Associates

Specializing in Occupational and Environmental Health Sciences